STUDY

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European Parliament

Research for TRAN Committee - Modal shift in European transport: a way forward

Transport and Tourism

Policy Department for Structural and Cohesion Policies
Directorate-General for Internal Policies
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Abstract

The study provides a comprehensive analysis of the progress and potential of modal shift from road to more sustainable transport modes, with respect to the policy objectives set in the 2011 White Paper on transport. The study focuses both on passenger and freight transport, highlighting main barriers and factors that are hampering a more effective modal shift at EU level, and providing policy recommendations for the way forward.

This document was requested by the European Parliament's Committee on Transport and Tourism.

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LIST OF ABBREVIATIONS

aaS	as-a-Service
ACN	Aircraft's Classification Number
ANPR	Automatic Number Plate Recognition
AVE	Alta Velocidad Española (Spanish high speed rail service operated by the Spanish national railway company)
BRI	Belt and Road Initiative
CEF	Connecting Europe Facility
CLECAT	European Association for Forwarding Transport, logistics and Customs services
CEMT	Classification of European Inland Waterways
CNCs	Core Network Corridors
CRCO	Central Route Charges Office
DB	Deutsche Bahn (main German railway company)
DG ENER	EC's Directorate-General for Energy of the European Commission
DG MOVE	EC's Directorate-General for Mobility and Transport
DG TAXUD	EC's Directorate-General for Taxation and Customs Union
EC	European Commission
ECA	European Court of Auditors
EESC	Economic and Social Committee
EIB	European Investment Bank
EMSA	European Maritime Safety Agency
EMSW	European Maritime Single Window
EP	European Parliament
EPF	European Passenger Federation
EPOMM	European Platform on Mobility Management
ERDF	European Regional Development Fund
ERTMS	European Rail Traffic Management System

ESI Funds	European Structural and Investment Funds
ETA	Estimated Time of Arrival
ETCS	European Train Control System
EU/EU-28	European Union/ All EU Member States
EU-13	EU Member States which joined the EU after 2004
EU-15	EU Member States before the 2004 EU enlargement
EUROSTAT	Statistical Office of the European Union
HaCon	HaCon Ingenieurgesellschaft mbH (German consultancy)
HC	Hydrocarbon
HGVs	Heavy Goods Vehicles
HSR	High Speed Railways
ICE	German Intercity Express train
ICAO	International Civil Aviation Organization
ICT	Information and Communication Technology
IMO	International Maritime Organisation
INEA	Innovation and Networks Executive Agency
IT	Information Technology
ITF	International Transport Forum
ITS	Intelligent Transport Systems
ITU	Intermodal Transport Unit
IWW	Inland Waterways
LNG	Liquefied Natural Gas
KPIs	Key Performance Indicators
MaaS	Mobility as a Service
MIMP	Multimodal Information, Management and Payment System
MSCP	Marginal Social Cost Pricing
MTOW	Maximum Take-Off Weight

NOx	Nitrogen Oxides
NFC	Near-field Communication
NMS	New Mobility Service
NS	Nederlandse Spoorwegen
NSW	National Single Window
NTV	Nuovo Trasporto Viaggiatori (Private rail company operating in Italy)
ÖBB	Österreichische Bundesbahnen
OECD	Organisation for Economic Co-operation and Development
OEM	Orient East Med Corridor
OSS	One Stop Shop
PaPs	Pre-arranged Paths
p-km	Passenger-kilometre
PRM	Persons with Reduced Mobility
PM	Particulate Matter
R&D	Research and Development
RENFE	Renfe Operadora (Spanish state-owned railway company)
RFCs	Rail Freight Corridors
RFI	Rete Ferroviaria Italiana
RFID	Radio-Frequency Identification
RIS	River Information Systems
RRT	Rail-Road Terminal
SGKV	Studiengesellschaft für den Kombinierten Verkehr (Study Association for Combined Transport, German company)
SNCF	Société nationale des chemins de fer (French national railway company)
SOx	Sulphur Oxides
SSS	Short Sea Shipping
SUMP	Sustainable Urban Mobility Plan

SW	Single Window
TEN-T	Trans European Network-Transport
t-km	Tonne – kilometre
TRACC	Transport Accessibility at Regional/Local Scale and Patterns in Europe Project
TRAN	Committee on Transport and Tourism of the European Parliament
TSIs	Technical Specifications for Interoperability
UIC	Union internationale des chemins de fer (International Union of Railways)
UMP	Urban Mobility Package
UN/CEFACT	United Nation Centre for Trade Facilitation and Electronic Business
UNECE	United Nations Economic Commission for Europe
UK	United Kingdom
VAT	Value-Added Tax

COUNTRY CODES

AT	Austria
BE	Belgium
CY	Cyprus
CZ	The Czech Republic
DE	Germany
DK	Denmark
EE	Estonia
EL	Greece
ES	Spain
FI	Finland
FR	France
HR	Croatia
HU	Hungary
IE	Ireland
IT	Italy
LT	Lithuania
LU	Luxembourg
LV	Latvia
MT	Malta
NL	The Netherlands
PL	Poland
PT	Portugal
RO	Romania
SE	Sweden
SI	Slovenia
SK	Slovakia
UK	The United Kingdom

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EXECUTIVE SUMMARY

Background

The purpose of the study was to undertake an up-to-date and thorough analysis of the progress, potential and further challenges for the EU in transferring part of road transport to more sustainable modes, as set out in the 2011 White Paper on transport. This strategy set an ambitious goal of reducing by 60% greenhouse gas emissions from transport by 2050 compared to the level of these emissions in 1990. To achieve this, overall objectives regarding modal shift have been set, such as a 30% shift of EU road freight over 300 km to more sustainable modes of transport (i.e. rail and waterborne transport) by 2030 (and more than 50% by 2050). Additionally, the 2011 White Paper on transport proposes that by 2050, the majority of medium-distance passenger transport should be by rail, and that by the same year a European high speed rail network should have been completed. This study particularly focused on the timeframe 2011-2018, in order to better evaluate whether the policies and measures that have been implemented and which are currently in force are delivering the expected outcomes.

Aim

The study offers an in-depth analysis of the most pressing issues and trends relating to passenger and freight transport, which are likely to impact and influence modal shift. Starting from the most recent data and statistics available from international and European sources, the study provides a clear overview and robust evidence about the current situation and trends regarding modal shift. The study pays particular attention to several factors (i.e. access charges, interoperability, EU financing) that may influence the cost of different transport modes and therefore modal choice. The study is intended to support the Members of the Committee on Transport and Tourism (TRAN) of the European Parliament on what could be done, in particular at the EU policy level, to further support the process and provide useful insights and recommendations for possible further initiatives.

Findings

The number of **factors** influencing **modal** shift and the **choice** of transport modes is widespread. Key determinants for passenger transport are linked to spatial patterns (e.g. urban density and the proximity to infrastructure and services and journey characteristics) and socio-demographic characteristics (e.g. car ownership, household size, occupation and wage levels). Key determinants for freight transport are related to the shipment characteristics and may depend on cost, time and quality of different transport services.

Despite an increase in freight volumes, the **modal share** of road, rail and inland waterway freight transport remained **substantially unchanged** between 1996 and 2016, both for passenger and freight transport, with road transport showing a slight increase. Looking at future projections, road transport is expected to keep its predominant position both for the passenger and freight sectors. However, its modal share is expected to decrease by a few percentage points, mainly to the benefit of rail transport.

The analysis of the progress in the development of the network and in the application of the EU and national regulation has shown that:

- the **density** of rail and inland waterway (IWW) networks differs across the EU, as does the provision of ports and intermodal terminals. Therefore, multimodal connectivity within Member States and their regions is diverse, with the highest connectivity seen in the Benelux area and western Germany. The designation of the TEN-T network – both core and comprehensive – and the rail freight corridors (RFCs) intends to create an integrated system of infrastructure aimed at ensuring an efficient level of service for freight and passenger transport. The levels of completion of the core network are low for road and conventional rail, and even lower for the high speed rail network. The implementation of the IWW network is at a more advanced stage.

- Regarding **high speed rail**, the most extensive networks are in Spain and France, followed by Germany and Italy. Other countries such as the Czech Republic, the three Baltic States, Poland, Portugal and Sweden have planned to implement new high speed railway lines, but the extent of the network is still far from the objectives set in the 2011 White Paper on transport, while there are also issues in relation to the interoperability of the different national high speed rail networks.
- **Cross-border interoperability** in the rail sector is still far from being fully achieved, as many technical and administrative barriers are still present on the ground (e.g. in relation to gauges, signalling, electrification and speed control, power systems adopted, etc.). Road and IWW are more interoperable, largely as they do not face the same levels of complexity in making infrastructure interoperable, as railways do.
- Different **access charging schemes** are applied across the EU road network, both for light private vehicles and HGVs. These include distance-based access charges, time-based charges and tolls paid for the use of specific sections of the network. Currently, there is no common approach across the EU, although a transition to either distance-based or time-based systems can be observed over the last years. In the rail sector, access charges are differentiated by train type, the location of the line or node in the network and the time of the service provided. Regarding other transport modes it is worth noting the increased consideration being given to the environmental impact of ships in determining the level at which port fees are set. Low access charges are generally applied to IWW, which only cover a low proportion of the total expenditure on the infrastructure.
- The application of **multimodal payment and ticketing systems** is becoming more and more popular, enabling access to more updated and reliable information on public transport services, especially in urban areas. Several examples and good practices have been implemented, while many different technologies are currently being used.
- The importance and the need to establish a **Single Window** (single access point) and one-stop-shop for administrative procedures in all transport modes across the EU has been recognised by several European bodies and policies. Currently, the implementation of Single Windows at the EU level is mainly concerned with maritime transport. The development of a prototype Single Window demonstrated the potential benefits relating to the reduction of administrative procedures through simplified and harmonised electronic reporting.
- **Urban areas** have been identified since 2013 as an important part of the TEN-T network. Transport demand is concentrated in cities, where an increasing proportion of the population lives and where a lot of relevant activities take place, so they are the prime location for intermodal interchanges. More integration across a range of elements is needed, including physically at specific locations, timetables, information and ticketing. The details of the type and extent of integration that is needed depends on local characteristics. Integration between modes can be improved through the use of technology, such as mobile phone applications for travel planning and payment.
- Multimodal transport projects are funded through a different range of **European funds**, in order to achieve the objectives set by the 2011 White Paper on transport. The analysis of data conducted in the framework of this research indicates that a small share of fund is allocated to multimodal projects and an unbalanced distribution of multimodal TEN-T projects between EU Member States. The allocation of CEF funds is even more unbalanced, since about 90% of these have been dedicated to multimodal projects within the EU-15 Member States.

Main Conclusions

Due to several reasons, **a significant shift to less carbon intensive transport modes is still far from being fully achieved**. The analysis carried out for the purpose of this study clearly highlighted that road freight is the dominant transport mode. Moreover, current projections seem to confirm that no particular shift between modes occurred in the period 2010-2016 and long-term prognoses for 2050 suggest that road transport will maintain its dominant position for both passenger and freight transport. Whilst the modal share for road freight transport is expected to remain stable in the long perspective, this share for road passenger transport is expected to decrease from 74% in 2015 to 69% in 2050, expressed in passenger-kilometre (p-km).

Road transport is subject to high levels of taxation, but has a relatively inelastic demand. The possibility that the policies set by the 2011 White Paper on transport could significantly influence modal shift are therefore limited, and likely to be effective only if targeted to specific demand segments (e.g. through urban pricing, increased levels of charges for the use of infrastructure in environmentally sensitive areas, etc).

The potential for modal shift is higher where transport demand is concentrated; for passengers this is in urban areas, while for freight this is where multimodal connectivity is at its highest. Urban areas – particularly the largest agglomerations – are where modal shift is more achievable. There are **many measures** that potentially contribute to modal shift in urban areas, including the provision of infrastructure for alternative modes, the implementation of shared mobility and ITS, vehicle access restrictions and the integration of ticketing, payment and information for public transport. Concerns about **congestion** and **pollution** in cities also mean that local residents are more open to using more sustainable transport modes.

Rail could deliver further modal shift in specific transport demand segments, but at the cost of large investments. The **development of** high speed railway (**HSR**) alone does not seem to be sufficient to shift significantly passengers from road to rail. Due to the high costs related to HSR, **investments** should focus only where HSR has most potential, and also on **upgrading** selected **sections** of **conventional lines** – where the potential for modal split is higher - and the **improvement** of the **reliability** of HSR and conventional services. With respect to **multimodal freight transport**, the ongoing process of amending the **Combined Transport Directive** is expected to facilitate further the development of multimodal transport. The investment in multimodal projects (e.g. in the rail-road terminals (RRT) or in inland waterway terminals) has been low compared to other infrastructure, so far, which needs to be addressed.

Technology is important in helping to deliver modal shift for both passenger and freight transport. However: (i) for passengers, it could lead to a modal shift between modes that are alternatives to road; and (ii) for freight, road transport has a higher potential to change vis-à-vis rail.

Three cross-sectional barriers have been identified relating to the **lack of a level playing field** between the modes. First, it is important to ensure that all modes of transport pay their full external costs. Second, the way in which different modes are taxed differs between modes and across Member States. Third, the favourable tax treatment of company cars and the fuel that they use.

Specific barriers for rail freight are: (i) an ongoing lack of cross-border interoperability; (ii) the complexity of transport chains, which is a particular challenge for multimodal chains; (iii) slow implementation of the measures needed to deliver a single European rail transport network; (v) slower technological innovation in the rail freight sector; and vi) a lack of knowledge and sufficient exchange of information.

Specific barriers for IWW are: (i) high costs resulting from a lack of intermodal infrastructure; (ii) the decreased navigability of rivers resulting from climate change impacts; (iii) missing links; iv) lack of willingness to share customer data as a result of concerns around confidentiality; and (v) the lack of availability and transparency of freight flow information in combination with limited Information and Communications Technologies (ICT) facilities.

Specific barriers for medium-distance passenger transport are: (i) an insufficient development of the high speed rail network; and (ii) challenges posed by modes constituting an alternative for the road transport, particularly in terms of convenience and price, and a lack of competition in high speed rail services.

Specific barriers in urban areas are: (i) transport and land use planning that has facilitated the use of private motorised vehicles above other modes; and (ii) lack of integration within public transport.

Recommendations

The main recommendations that can be proposed are as follows:

1. **Set objectives that are clearly expressed and measurable over time.** The modal shift targets set out in the 2011 White Paper on transport are quite general and, as demonstrated within the study, can be interpreted in different ways and thus lead to different interpretation of whether or not a target has been achieved. For example, different modal shares will be obtained by calculating modal split in terms of passengers or tonnes moved compared to measurements made on the basis of the distance travelled by passengers in terms of p-km or tonne-kilometre (t-km). Similarly, different modal shares would be estimated if the focus was on different journey types, e.g. longer-distances compared to intra-city travel.

2. **Establish targets differentiated by transport segment.** Looking at the evolution of demand, it is clear that some demand segments can change quickly and thus deliver the desired results sooner. The case of intermodal transport is a good example, as its increase has driven the growth of IWW and rail freight demand over the last decade. In a context in which logistics is changing and other EU and national policies (e.g. on power generation) influence demand patterns, it is important to differentiate targets by segment. To this end, the data collected should be made available at a more disaggregated level so that progress can be better monitored.

3. **Adopt clear and definite measures to level the playing field.** In order to avoid distortions in the market and to prevent the introduction of regulations that may be based on incorrect background assumptions, it is paramount that the findings of the wide range of literature and studies that have been undertaken with specific reference to the EU market are taken into account in a coherent manner. For example, stakeholders and experts often claim that the differential treatment of the different modes, and the different charges and taxes that they face, are not fairly defined and applied according to the "polluter pays" principle.

4. **Redefine the priorities of the interventions on the network.** Over the last 10 years, the majority of EU funding of infrastructure has been invested in rail infrastructure (specifically on cross-border routes and in the context of Cohesion Policy). While the completion of the Core Network Corridors (CNCs) is still considered to be a strategically important goal that needs to be pursued, the timing and the way it is achieved can be revised by prioritising the interventions that are more cost effective. This could lead to a focus away from projects targeting the high speed rail network (focusing only on those with a potential for strong demand) and instead putting more resources into ensuring interoperability between national networks.

5. **Strengthening support to investment in multimodal terminals.** Multimodal connectivity is not even across the EU; while it is acknowledged that the Core Network Corridors (CNCs) and the Rail

Freight Corridors (RFCs) will represent the main axes for the development of intermodality[1] across the EU, it is important that the whole EU territory is given the same opportunity to be connected by rail, following the principle of cohesion and accessibility policy. The distance that needs to be covered, and the associated costs, of the road haulage that occurs before and after transport on another mode are amongst the main barriers to multimodal transport: the improvement of accessibility should help to deliver the potential of this type of transport. This, however, does not mean that the planning of terminals and investment must follow an approach that aims to deliver the same level of multimodal connectivity everywhere: investment should be based on clear indicators of the demand levels and of the socio-economic conditions of the likely catchment area of the terminal.

6. **Support a consistent development of information sharing in freight transport.** Electronic information in transport is key for different reasons: informing about the services available, about the terminals and logistics platforms in terms of their accessibility, availability, transhipment facilities, services offered, performance etc. The European Commission has already funded a web-based portal prototype containing this information; this could be further developed and maintained in order to provide comprehensive and updated information.
7. **Support the information and the integration between the modes for passenger transport.** Multimodality is also essential for shifting passenger transport from private vehicle use to the use of more sustainable modes of transport. In this respect, increased interest in the concept of Mobility-as-a-Service (MaaS) is pushing the development of platforms that can deliver a good integration of systems for information, ticketing and payment.
8. **Promote further the adoption of Sustainable Urban Mobility Plans (SUMPs) and related actions in urban nodes.** This should be accompanied by the monitoring of the effectiveness of the measures implemented, through the adoption of common indicators measuring the performance of the plans. This is an area where the European Commission is already investing a lot of time and resources, given the growing importance of urban areas as centres of population and of economic activities. While the responsibility for planning and funding cannot be made to be dependent on EU intervention, it is important that the cities adopting such plans have common approaches and indicators to measure their progress towards common policy objectives.
9. **Support the development of new technologies for both freight and passenger transport**. Multimodality and the future generations of mobility systems for passengers and freight require promotion and funding, including:
   - the research and innovation in areas that would help to achieve multimodality, but which are not specifically related to a particular mode of transport, such as digitalisation, automation, artificial intelligence, energy management, etc.;
   - the development and implementation of any new technologies within a specific mode of transport, while ensuring that this does not adversely affect integration, connectivity and interoperability.

[1] Please see footnote 7 in section 2.1.1 for the definition of intermodality.

1. INTRODUCTION

1.1. General context

Modal shift is an important element of any transport policy framework that aims to improve the environmental performance of transport.

Where buses, trains and barges are used at a high capacity, these modes can be more beneficial to the environment, in terms of their environmental impact per person or tonne moved. Similarly, in urban areas, walking, cycling and public transport, also bring benefits to the environment, as well to public health, as these modes require people to be more active (people need to walk to public transport stops).

Modal shift contributes to a better use of existing capacity and thus to an increase of the efficiency of the transport system as a whole.

For both urban and inter-urban travel, moving passengers and goods around by bus, train and inland waterway is often more efficient – in terms of the use of finite infrastructure – than moving people and freight in cars, vans and trucks. In urban areas, short journeys made on foot or by bicycle can also be more efficient in terms of the use of infrastructure.

A related concept is **multimodal transport**, which underlines the importance and role of each mode within a transport system where there is a seamless integration between the different modes so that each one is used in accordance with its strengths and weaknesses. The European Commission (further referred to as 'the Commission'), in common with national and local public authorities, pursues a policy of multimodality by ensuring better integration between transport modes. It does this at all levels of the transport system by supporting the development of infrastructure and measures to enhance interconnections between the single modes at links or nodes. A truly multimodal transport system will have modal shares that are more efficient and sustainable and which are likely to be less dominated by private car travel and trucks compared to the current situation. In order to promote a more balanced modal shift and to put the focus on multimodality, the Commission announced that 2018 is the 'Year of Multimodality'.

Since the early nineties, there has been an increasing amount of attention paid at the European level to the transport sector, which has led to numerous policy measures and interventions, combined strategically in the form of White Papers. The first White Paper published by the Commission in 1992, entitled "The Future Development of the Common Transport Policy: A Global Approach to the Construction of a Community Framework for Sustainable Mobility", was mainly focused on opening the market in line with the broader focus on the completion of the Single Market at the time. The second White Paper submitted by the Commission in 2001, entitled "European transport policy for 2010: time to decide", proposed around 60 measures to develop a more balanced transport system, in terms of use of the different transport modes, thus facilitating modal shift.

The most recent White Paper on transport from 2011, entitled "Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system", reflected the focus of the so-called 'Europe 2020 Strategy'. In contrast to the previous White Papers, which both had a 10-year vision, the 2011 version establishes ten goals and a long-term roadmap to 2050, which foresees 40 strategic initiatives. Such a long-term vision is consistent with decarbonisation agenda, which focuses on reducing emissions by 2050 and which is an important element of the 2011 White Paper on transport. Two intermediate dates – 2020 and 2030 – have also been identified to monitor the progress made at European level.

The 2011 White Paper on transport sets different goals for different types of journey – i.e. those within cities (urban), between cities (interurban) and for long distance transport. For urban transport, the main goal foresees a large shift to less polluting cars and cleaner fuels, while for aviation and maritime transport, there is a focus on rolling out low carbon fuels. Other actions proposed relate to reducing casualties from accidents and delivering the full application of the "user pays" and "polluter pays" principles.

Five of the goals specifically refer to, or may have close links and implications for, modal shift and multimodality, i.e.:

- By 2030, 30% of road freight over 300 km should be moved using other modes, such as rail and water, increasing to 50% by 2050;
- By 2030, the length of the existing high speed rail network should be tripled and a dense railway network should be maintained in all Member States. By 2050, the European high speed rail network should be complete and the majority of medium-distance passenger transport should go by rail;
- By 2030, there should be a fully functional and EU-wide multimodal TEN-T 'core network', while by 2050 there should be a network of high quality and capacity, with a corresponding set of information services;
- By 2050, all core network airports should be connected to the rail network, preferably the high speed network, while all seaports should be connected to the rail freight network and, where possible, the inland waterway system;
- By 2020, a framework for a European multimodal transport information, management and payment system should be established.

Since the publication of its 2011 White Paper on transport, the Commission has been taking forward various initiatives (including legislative ones) to support the achievement of the strategic goals set in the document. European funds have been supporting the development of transport infrastructure and transport in general (in line with the EU transport policy), through the European Structural and Investment Funds (ESIF) at a regional and local level, through the Connecting Europe Facility (CEF) and through the Cohesion Funds from an inter-urban perspective.

The Implementation Report of the 2011 White Paper on transport, which reviewed progress in 2016, showed that – at the time of writing – there had been little progress towards the achievement of the goals set in 2011 regarding modal shift.

1.2. Objectives of the study

The results of this study are intended to support the Members of the European Parliament, and in particular the Members of the Committee on Transport and Tourism, i.e. the TRAN Committee, in the debate that will accompany the European Commission's announcement of 2018 being the 'Year of Multimodality'.

The goal of the study is to analyse the progress achieved in relation to modal shift and, based on this, to assess whether there is further potential for the EU to transfer more transport that is currently undertaken on roads to more sustainable modes, and to analyse the related challenges. The study aims to provide the Members of the TRAN Committee with clear conclusions and recommendations on what could be done, in particular at the EU policy level, to further support the process.

In this respect, the study carries out three distinct tasks: (i) description of the situation and major trends in terms of modal shift both at the EU and national levels; (ii) evaluation of any progress that has been made in shifting part of the road freight transport and passenger traffic to more sustainable modes since the adoption of the 2011 White Paper on transport; (iii) provision of recommendations.

The first chapter provides a comprehensive overview of the current situation, as well as an understanding of the multiple factors that play a role in delivering modal shift, building on relevant literature that has been produced since 2011.

Based on the findings and overall picture provided in the first chapter, the rest of the study assesses the progress that has been made in the implementation of modal shift policy, distinguished by transport mode. The analysis has been enhanced by valuable insights and contributions from: (i) a comprehensive literature review covering all the issues of relevance to modal shift; (ii) interviews with experienced and well-known transport experts based on a set of detailed questions on specific topics; (iii) a stakeholder consultation based on a questionnaire covering the same range of topics that targeted the most relevant organisations with an interest in the area. The interviews with experts were undertaken over the phone, while the questionnaire underlying the consultation was distributed by email. The list of experts interviewed and the list of stakeholders that were consulted can be found in the Annex.

This study is divided into 7 chapters:

The current **Chapter 1** contains some background information concerning the EU strategic objectives on modal shift in transport.

Chapter 2 provides an overview of the progress in terms of modal shift in the EU and in individual Member States.

Chapter 3 provides a comprehensive overview of the progress in specific network and policy development that are deemed to favour the modal shift.

Chapter 4 assesses the further potential for modal shift, based on the measures implemented and the results achieved.

Chapter 5 identifies any existing barriers that might be hampering the effective shift from road to more sustainable transport modes.

Chapter 6 discusses the way forward by identifying additional measures that could be deployed by the EU and/or its Member States that could further stimulate modal shift.

Chapter 7 draws final conclusions and makes recommendations.

2. OVERVIEW ON THE PROGRESS: MODAL SPLIT AND MODAL CHOICE

KEY FINDINGS

- Despite an increase in freight volumes, the modal share for road, rail and inland waterway **freight transport** remained **substantially unchanged between 1996 and 2016**. In 2016, road transport accounted for around half of total freight moved (50.9%), measured in t-km, whilst rail transport accounted for 11.6%.
- For **passenger transport**, over the same timescales, there was **not a significant shift from road to more sustainable transport modes**. In 2016, passenger cars accounted for 71.0% of passenger transport measured in p-km, which was a slight decrease compared to their modal share in 1996 (73.2%); over the same period, the modal share of rail and public transport has barely changed.
- Looking at future projections, **road transport is expected to keep its predominant position both for the passenger and freight sectors**. However, its modal share is expected to decrease slightly, mainly to the benefit of rail transport, which should increase the modal share of rail, for both freight and passenger transport, by a few percentage points.
- **Modal choice** is the result of a **decision process** of choosing between different transport alternatives. The number of **factors influencing** modal shift and the choice of transport modes is **widespread**.
- **Key determinants for passenger transport** are linked to **spatial patterns** – such as urban density and the proximity to infrastructure and services and **journey characteristics**. **Socio-demographics characteristics**, such as car ownership, household size, occupation and wage levels, also play an important role.
- **Key determinants for freight transport** are related to **cost, time and quality of the service** demanded and offered. The weight of the different determinants depends on the **shipment attributes**.

This chapter sets out the state of play in relation to existing modal shares, their evolution over time (section 2.1) and on the criteria that drive the modal choice according to the characteristics of demand (section 2.2).

2.1. Overview of transport modal shares

Modal share can be defined as the share of people – or freight – using a particular mode of transport (including cycling and walking) within a particular area (from the urban scale to the national and international ones). Modal share can be calculated for passenger and freight transport using different units, such as number of trips, the volume or weight of goods transported or the distance travelled by passengers in terms of passenger kilometres (p-km[2]) or goods in terms of tonne kilometres (t-km[3]). The modal share of different modes of transport is typically displayed as a percentage value for each mode. Modal share can also be measured for specific trip types (e.g. journeys to work, type of commodities for freight) or for the

[2] A passenger-kilometre, abbreviated as p-km, is the unit of measurement representing the transport of one passenger by a defined mode of transport (road, rail, air, sea, inland waterways etc.) over one kilometre (source: Eurostat).

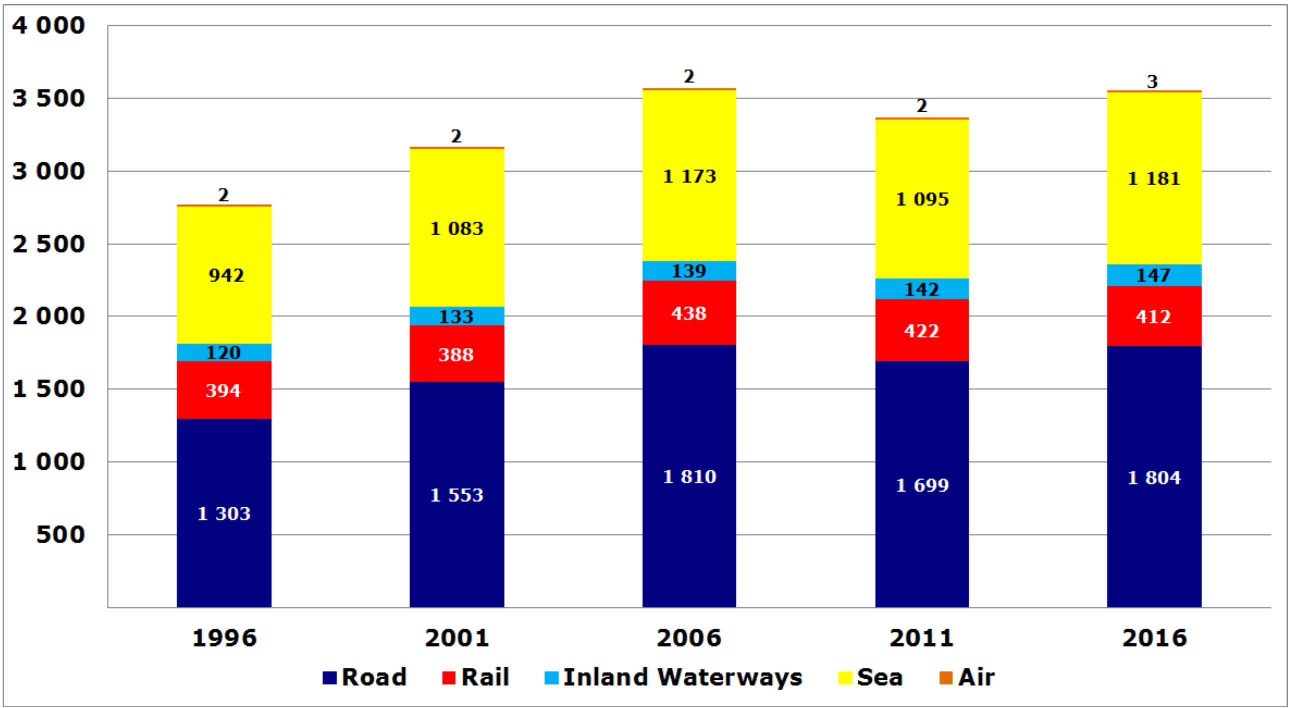
[3] A tonne-kilometre, abbreviated as t-km, is a unit of measurement of freight transport which represents the transport of one tonne of goods (including packaging and tare weights of intermodal transport units) by a given transport mode (road, rail, air, sea, inland waterways, pipeline etc.) over a distance of one kilometre. Only the distance on the national territory of the reporting country is taken into account for national, international and transit transport (source: Eurostat).

total number of all journeys undertaken in a given period of time. The data presented in this study for all the transport modes (road, rail, air, maritime) refer only to intra-EU travels, travel originating or going outside the EU are not included.

2.1.1. Freight transport

Long-term trends in freight transport, derived from Eurostat data, show a continuous growth from 1996 up to 2008 when, due to the economic crisis that affected EU Member States, the volumes reduced back to pre-crisis level. Since then, transport volumes have been slowly recovering, but the current levels are still lower than the ones observed before the economic crisis. Figure 1 shows the trend, expressed in billion t-km, for freight moved within the EU.

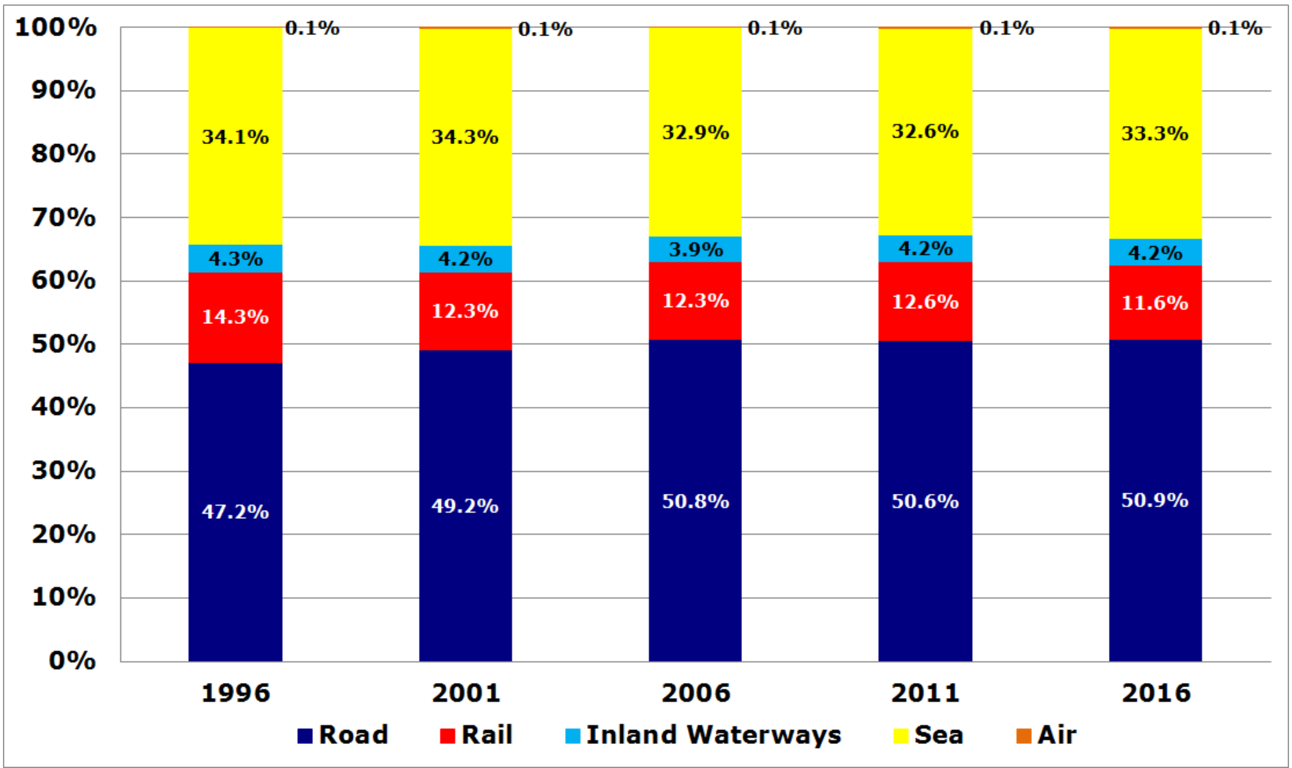
Figure 1: Freight moved in the EU between 1996 and 2016 (billion t-km)



Source: Authors' own elaboration based on Eurostat (2018)

The modal share between the different transport modes did not change radically in this timeframe, as shown in Figure 2. However, the road share has slightly increased over time, to the detriment of rail and sea modes.

Figure 2: Modal share of freight transport in the EU, between 1996 and 2016 (based on t-km)



Source: Authors' own elaboration based on Eurostat (2018)

In 2016, road transport accounted for around half of total movements (50.9%), while almost a third was undertaken by maritime transport (33.3%). Most of the remaining freight was moved by rail (11.6%), followed by inland waterways (IWW) at 4.2%, with only a negligible amount moved by air transport (0.1%). The most relevant change that can be observed over the timespan considered is the increase in the modal share of road transport (+3.7 percentage points), whereas rail and maritime transport both decreased (-2.7 and -0.7 percentage points respectively). However, over the last ten years, the market share of road transport has been quite unchanged.

Road transport is the predominant inland transport mode in almost all of the EU Member States (with the exception of Latvia and Lithuania; please see Table 1). In small countries that do not have rail or inland waterways, its share is 100% (Cyprus and Malta) or at a level that is very close to 100% (Greece and Ireland).

Table 1: Freight modal share (%) by country and inland mode (based on t-km)

Country	2011			2016		
	Rail	Road	IWW	Rail	Road	IWW
Austria	33.1	63.5	3.4	31.5	65.5	3
Belgium	12.2	73	14.8	11.6	73.1	15.3
Bulgaria	19	56.1	24.9	17.1	55.7	27.2
Croatia	22.4	71.2	6.4	17.3	75.5	7.2
Cyprus	-	100	-	-	100	-
Czech Republic	30.1	69.8	0.1	26.4	73.5	0.1
Denmark	12.4	87.6	-	11.1	88.9	-
Estonia	71.6	28.4	-	42.9	57.1	-
Finland	27.6	72.2	0.3	26.8	72.9	0.3
France	10.8	86.3	2.9	10.9	86.3	2.8

Country	2011			2016		
	Rail	Road	IWW	Rail	Road	IWW
Germany	19.3	71.3	9.4	18.8	72.4	8.8
Greece	1.8	98.2	-	1.3	98.7	-
Hungary	28.5	65.8	5.7	28.5	66.2	5.3
Ireland	1.1	98.9	-	0.9	99.1	-
Italy	11.2	88.8	0.1	14.5	85.5	0
Latvia	84.2	15.8	-	76.6	23.4	-
Lithuania	73.7	26.3	-	65	35	-
Luxembourg	10.5	78.4	11.1	6.2	87.9	5.9
Malta	-	100	-	-	100	-
Netherlands	6.3	48.2	45.6	6	49.4	44.6
Poland	29.9	70	0.1	24.7	75.2	0.1
Portugal	10.9	89.1	-	14.5	85.5	-
Romania	35.4	37.2	27.4	30.3	40.3	29.4
Slovakia	38.2	57.3	4.5	34.5	61.7	3.7
Slovenia	34	66	-	33.3	66.7	-
Spain	5	95	0	5.3	94.7	0
Sweden	34.8	65.2	0	29.4	70.5	0
United Kingdom	11.7	88.2	0.1	8.4	91.5	0.1
EU-28	**18.7**	**75.1**	**6.3**	**17.4**	**76.4**	**6.2**

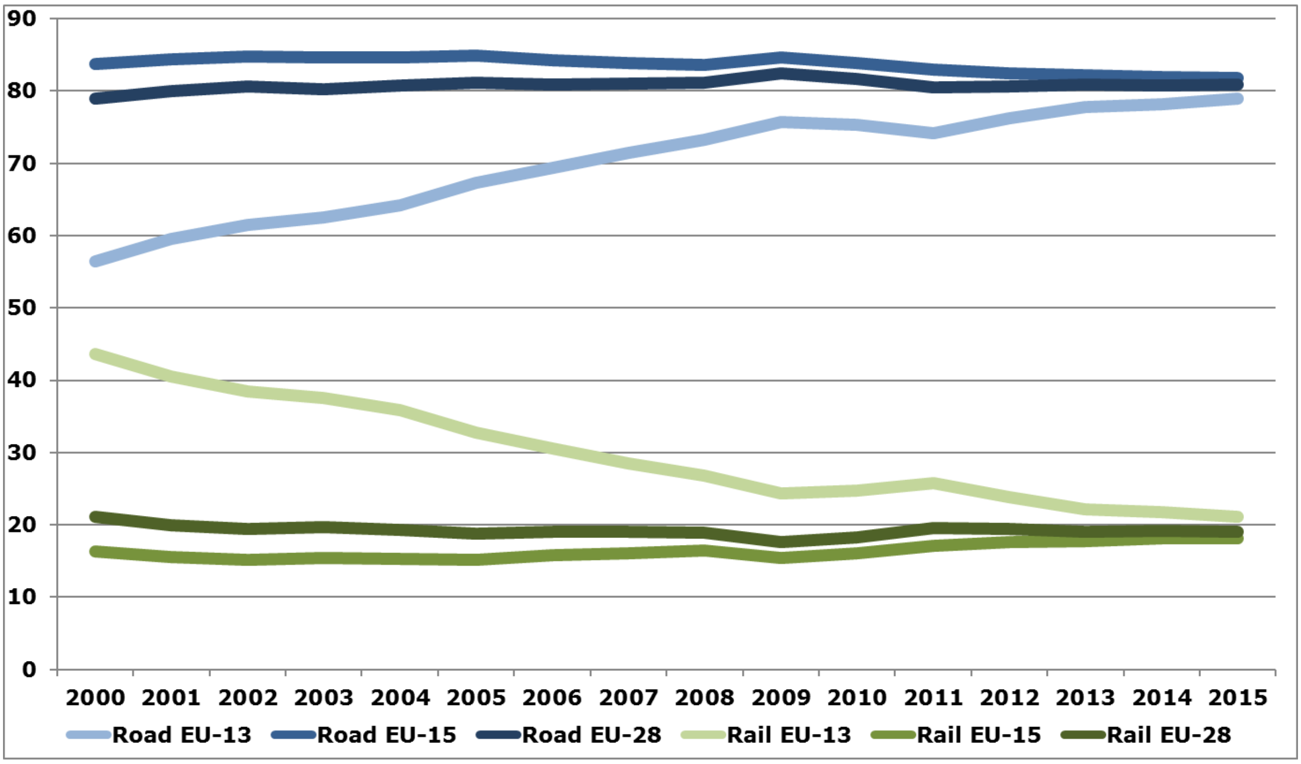
Source: Eurostat (2018)

The majority of the countries saw the share of rail transport slightly decrease between 2011 and 2016, with a change in most cases that amounts to no more than 2 percentage points. More significant decreases – of between 2 and 5 percentage points – were recorded in Croatia, the Czech Republic, Luxembourg, Poland, Romania, Sweden and the United Kingdom, as well as in the three Baltic countries (i.e. Estonia, Latvia and Lithuania) where the rail share has been affected by the reduction of the transport of energy products from Russia to the Baltic sea ports. Three Member States experienced an increase in the share of rail transport, i.e. Spain (+0.3 percentage points), Italy (+3.3 percentage points) and Portugal (+3.6 percentage points), where it reached a modal share of 14.5%. Figures for France and Hungary remained unchanged.

The importance of IWW freight transport is linked to the presence of navigable rivers and canals in a country: only 18 Member States use inland waterways for freight transport to a significant level. The highest modal share is found in the Netherlands, where the share of IWW almost matches that of road transport (44.6% for inland waterways against 49.4% for road). Romania and Bulgaria also have comparatively high modal shares for IWW (29.4% and 27.2% in 2016, respectively), which is partly explained by the consistent flows of traffic along the Danube River. In Belgium, the modal share is slightly above 15%.

Figure 3 below, shows the respective trends in the shares of road and rail transport over the last 15 years in all EU Member States, i.e. the EU-28, as well as separately for the EU-15 and the EU-13. The trends highlight a constant reduction of the modal share of rail for EU-13, which is now aligned with the EU-15 values.

Figure 3: Comparative trends of modal share of freight transport in the EU, the EU-15 and the EU-13 (based on t-km)



Source: Authors' own elaboration based on Eurostat (2018)

In order to better assess the state of play and to understand how far it is from the objective of the 2011 White Paper on transport, it is worth deepening the analysis by considering further data.

Data provided by Eurostat allow the estimation of the modal split in terms of the tonnes carried by each mode of transport. Focusing on the main land-based modes, Table 2 below illustrates the breakdown for selected representative years (2010, 2013 and 2016). With share between 87% and 88%, road freight transport by far accounts for the highest proportion of tonnage transported in the EU-28 during the entire period.

Table 2: Freight transport in the EU-28 by inland mode (million tonnes)

	2010		2013		2016	
	tonnes	%	tonnes	%	tonnes	%
Road	15 062	88.2%	13 786	86.7%	14 238	87.2%
Rail	1 477	8.7%	1 573	9.9%	1 537	9.4%
IWW	532	3.1%	543	3.4%	554	3.4%
Total	17 072	100.0%	15 903	100.0%	16 329	100.0%

Source: Authors' own elaboration based on Eurostat (2018)

Table 3 below provides an estimate of the volumes carried over distances longer than 300 km. While for road transport the data are provided by Eurostat by distance class, for rail and IWW the volumes, in absence of comprehensive sources, have had to be estimated: in the case of rail, it is assumed that 70% of rail traffic is run over distances longer than 300 km, while for IWW, which is characterised by shorter average distance, it is assumed that only 30% of the tonnes lifted are carried for more than 300 km. The share of road freight transport in this case is much lower, while the share of rail is much more relevant, registering values comprised between 36% and 39% during the entire period. However, a trend highlighting a shift from road to rail and IWW is not visible.

Table 3: Freight transport over 300 km in the EU-28 by inland mode (million tonnes)

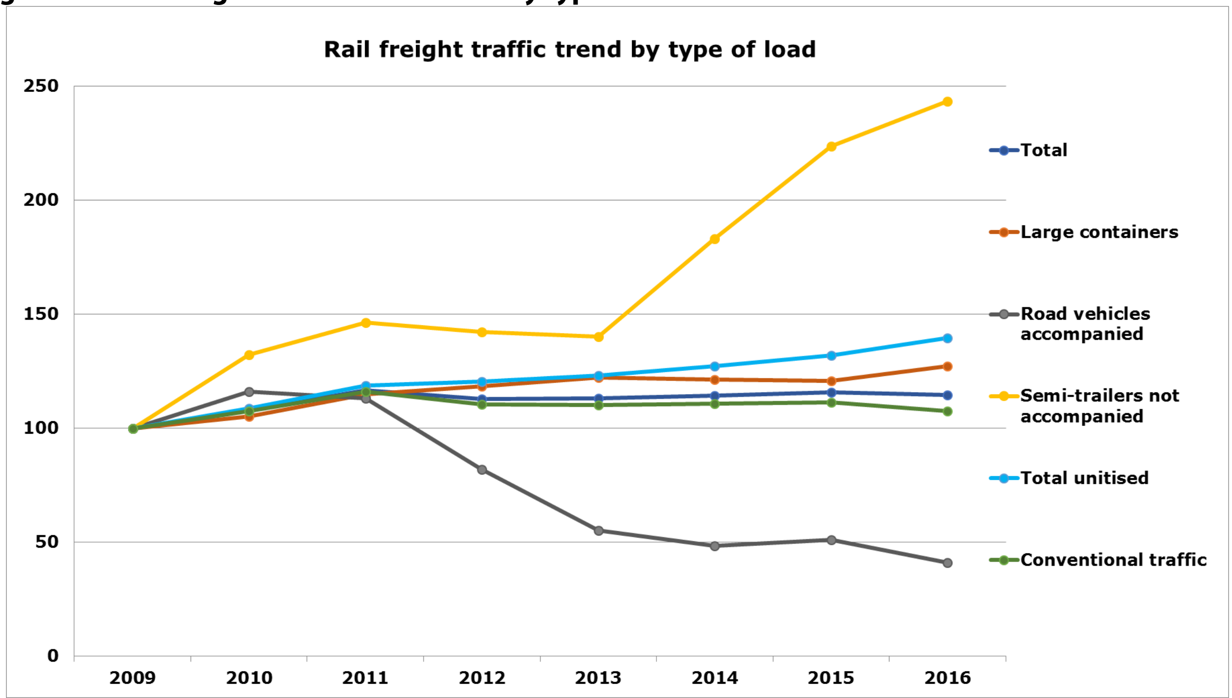
	2010		2013		2016	
	tonnes	%	tonnes	%	tonnes	%
Road	1 635	57.8%	1 586	55.7%	1 793	58.2%
Rail	1 034	36.6%	1 101	38.7%	1 117	36.3%
IWW	160	5.6%	163	5.6%	167	5.5%
Total	2 829	100%	2 850	100%	3 077	100%

Source: Authors' own elaboration based on Eurostat (2018)

Different conclusions can be drawn with respect to specific transport segments that have seen quite positive trends in terms of modal shift. This is the case of unitised freight transport in which cargo is carried in the same load unit (e.g. a container, a swap-body or a semitrailer) that can be transhipped from one mode of transport to another.

Figure 4 below highlights how rail intermodal transport has been growing more than the average since 2009. Namely, the highest growth can be seen for the carriage of semi-trailers; although this segment still represents only 20% of the intermodal rail sector, it is clear that the potential for additional modal shift could be found in this area. Conversely, the accompanied rail-road transport (i.e. the so-called "rolling motorway"[4]) is facing a continuous decline demonstrating that it is not the best way to shift goods from road to rail.

Figure 4: Rail freight: trends 2009-2016 by type of load[5]



Source: Elaboration of the authors based on Eurostat database (2018)[6]

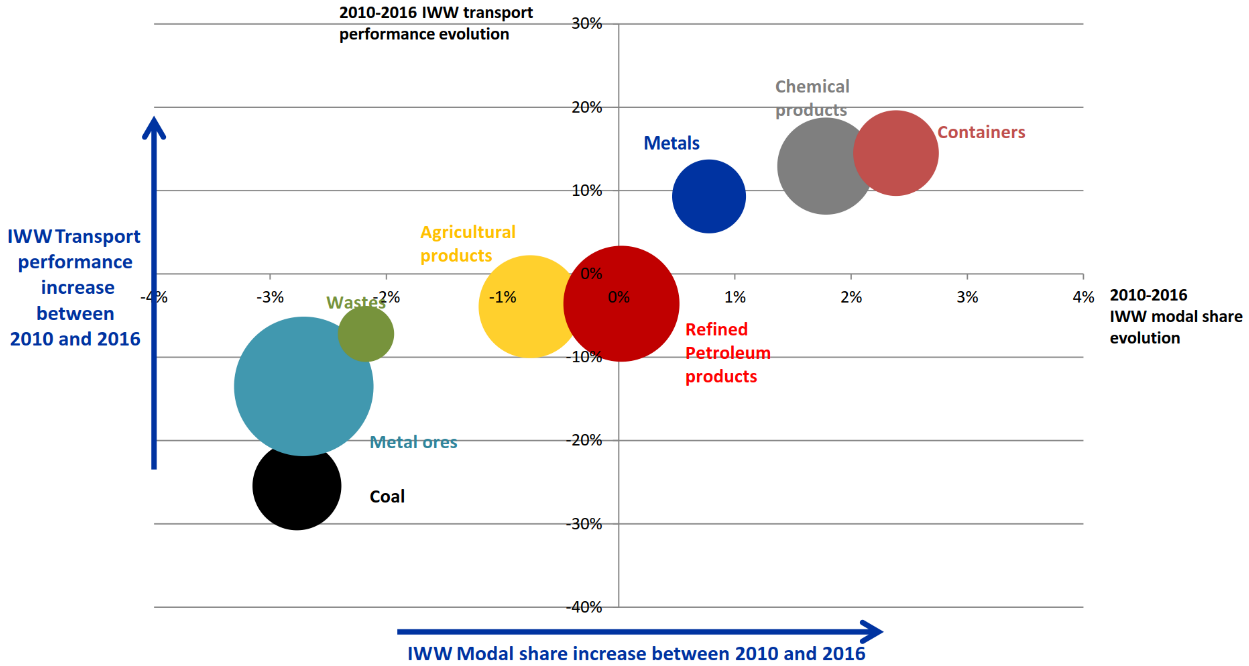
Similar considerations can be done for IWW. Figure 5 below illustrates the evolution of the demand for this mode of transport over the 2010-2016 timespan. It clearly shows that, while the traditional goods, such as raw materials and waste agricultural products carried by barges are declining, while growth opportunities have been found specifically in higher value sectors, such as chemical and containerised transport.

4 A "rolling motorway" is a special form of combined transport, in which full trucks are transported on special rail wagons, generally accompanied by the truck drivers, who travels in a passenger car.

5 Data were elaborated for 21 Member States for which the time series is consistent and complete; the sample represents more than 90% of the EU rail traffic.

6 Please see http://ec.europa.eu/eurostat/data/database (tran_im_umod).

Figure 5: IWW transport market segment comparison and the evolution in the EU between 2010 and 2016



Source: CCNR, Naiades Implementation Meeting

The available data suggests that multimodal transport[7] has improved, especially for the transport modes alternative to road and on long distance travel (e.g. in international trade). In particular, maritime, rail non-accompanied and inland waterways can reduce the overall transport and handling costs within the supply chain more than the others, possibly as a result of their economies of scale (e.g. large vessels and longer trains).

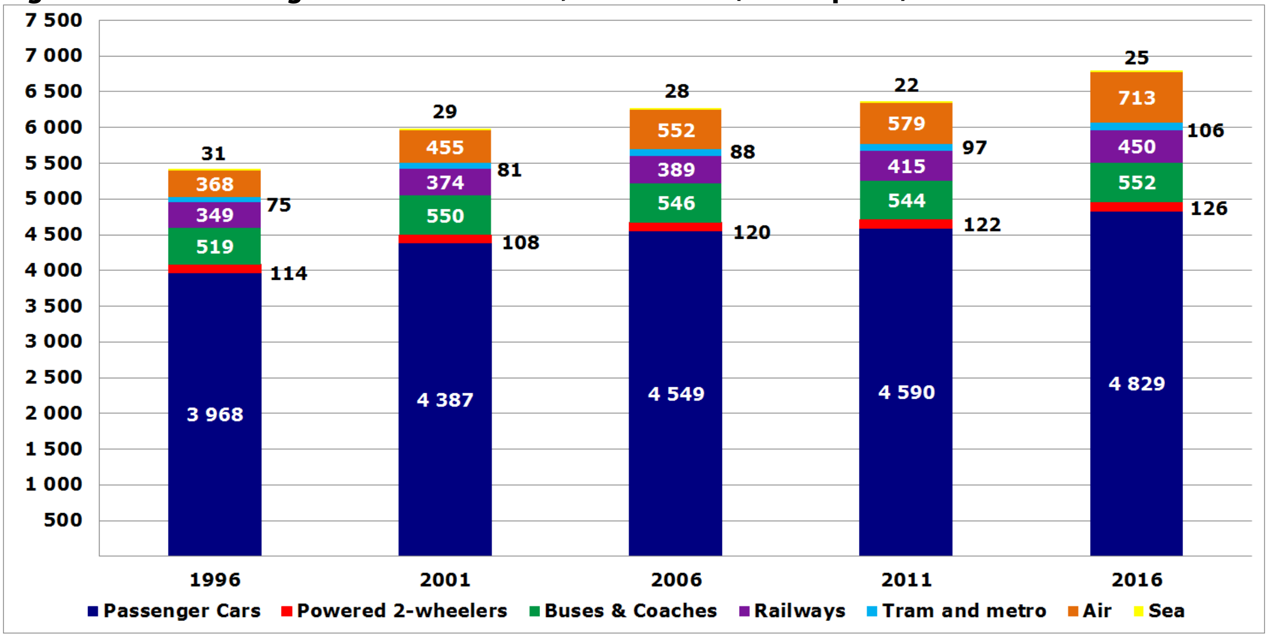
2.1.2. Passenger transport

Figure 6 below highlights the overall trend over the same timespan (1996-2016) for passenger transport within the EU. Volumes – expressed in billion p-km – have progressively increased during the entire timeframe analysed. Maritime transport, even with an already low modal share, has seen its volumes consistently decline between 1996 and 2016. The use of most of the other modes has increased over this time period, with the exception being the use of buses and coaches, which remained relatively stable between 2001 and 2016.

[7] In the text, goods transport involving more than one mode is classified according to the following definitions:

- **Multimodal transport**: Goods transportation that employs more than one mode of transport.
- **Intermodal transport**: Multimodal goods transportation where the cargo is carried in an intermodal loading unit throughout the entire journey.
- **Combined transport**: Intermodal goods transportation where the road legs of the journey are kept to a minimum, while the longest possible section of the distance is covered by non-road modes of surface transport.

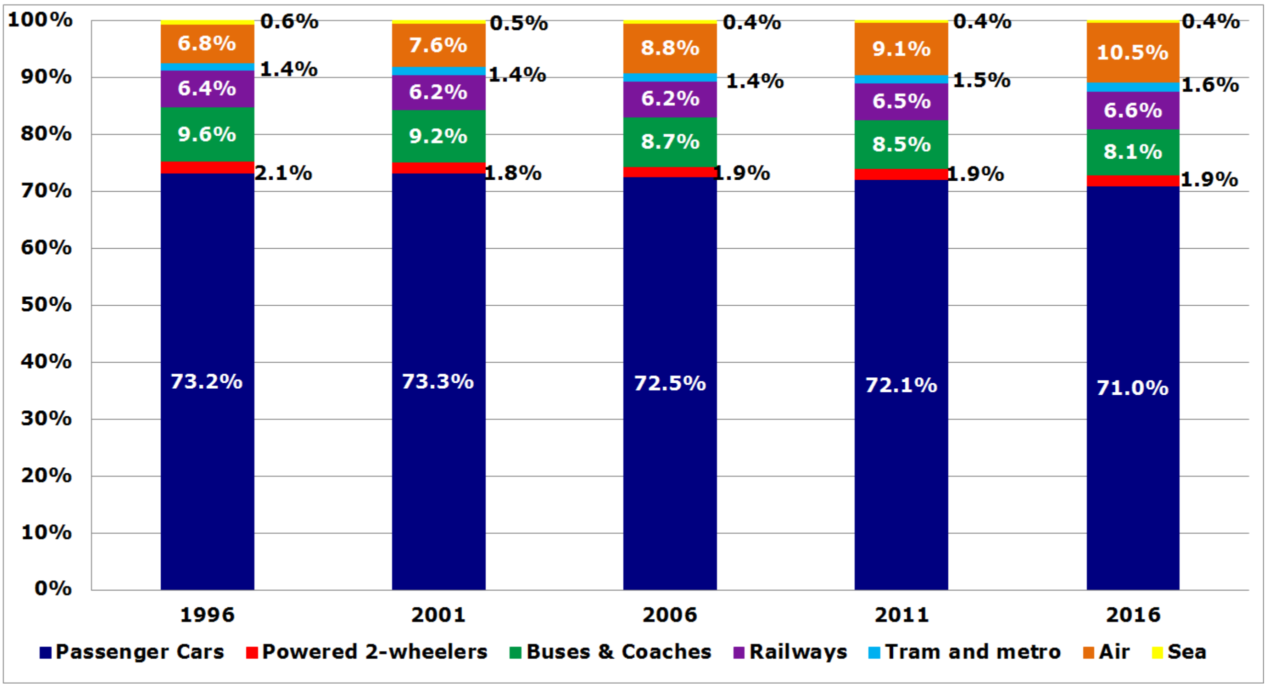
Figure 6: Passengers moved in the EU, 1996 - 2016 (billion p-km)



Source: Authors' own elaboration based on Eurostat (2018)

In 2016, passenger cars accounted for 71.0% of all passenger transport (please see Figure 7), which was a decrease compared to their modal share in 1996 (73.2%). Air transport had the next highest modal share of 10.5% in 2016, which was a considerable increase both as a percentage (+3.7 percentage points) and in terms of volumes, which almost doubled, since 1996. Rail accounted for 6.6% of total kilometres travelled by passengers in 2016, and this remained constant over the 1996-2016 timeframe. On the contrary, buses and coaches lost modal share, which reduced from 9.6% in 1996 to 8.1% in 2016.

Figure 7: Evolution of modal share for passenger transport in the EU, 1996 - 2016 (based on p-km).



Source: Authors' own elaboration based on Eurostat (2018)

Focusing on land-based passenger transport, thus excluding air and sea transport, according to Eurostat[8], passenger cars accounted for 82.9% of transport demand in the EU-28 in 2016, a proportion which has remained stable over the last decade. Coaches, buses and trolley buses had a modal share of 9.4% in the same year, whereas trains accounted for 7.7% of all traffic.

Table 4: Passenger modal share by country and inland mode (based on p-km)

Country	2011			2016		
	Trains	Passenger cars	Coaches, buses	Trains	Passenger cars	Coaches, buses
Austria	11.3	78.3	10.4	12.1	77.7	10.2
Belgium	7.7	79.5	12.8	7.7	81.8	10.5
Bulgaria	3.5	80.6	15.9	2.2	83.7	14.1
Croatia	4.9	84.6	10.5	2.7	85	12.3
Cyprus	-	81.7	18.3	-	81.4	18.6
Czech Republic	7.6	74.4	18	8.9	74	17.1
Denmark	10	80	10.1	8.6	81.6	9.8
Estonia	1.9	81.8	16.3	2	80.1	17.9
Finland	5	85.1	9.8	5.6	82.5	11.9
France	9.3	85.3	5.4	9.7	81.5	8.8
Germany	8.5	85.7	5.8	8.6	85.7	5.8
Greece	0.8	81.6	17.6	1	81.9	17.1
Hungary	10.2	68.3	21.5	9.3	69	21.7
Ireland	3.8	76.8	19.4	2.9	79.9	17.2
Italy	5.7	81.1	13.2	6.1	81.9	12
Latvia	4.9	76.2	18.9	3.4	81.5	15.1
Lithuania	0.8	90.8	8.3	1	89.9	9.1
Luxembourg	4.4	83.1	12.5	4.6	83.1	12.3
Malta	-	82.4	17.6	-	82.6	17.4
Netherlands	10.5	86.5	3	11	86	3
Poland	6.9	77.4	15.7	7.3	78.5	14.2
Portugal	4.5	89.2	6.3	4.2	89.1	6.7
Romania	5.3	78.5	16.2	4.2	80.1	15.7
Slovakia	7	77.3	15.7	9.4	74.8	15.8
Slovenia	2.3	86.6	11	2	86.3	11.8
Spain	5.6	80.9	13.5	6.6	81.6	11.8
Sweden	8.7	83.8	7.4	9.3	83.5	7.2
United Kingdom	7.8	86.3	5.9	8.8	86.5	4.6
EU-28	**7.4**	**83.2**	**9.4**	**7.7**	**82.9**	**9.4**

Source: Eurostat (2018)

Considering the modal shares in individual Member States, the highest shares of passenger cars in 2016 are recorded in Portugal and Lithuania, which both had modal shares close to 90%, while in the majority of Member States, the modal share of passenger cars ranges between 75% and 85%. Passenger transport by train is particularly high in Austria (12.1%) and the Netherlands (11%). While for the EU-28 as a whole, the share of rail is lower than that of coaches and buses, in Germany, France, Austria, the Netherlands,

8 http://ec.europa.eu/eurostat/statistics-explained/index.php/Passenger_transport_statistics#Modal_split.

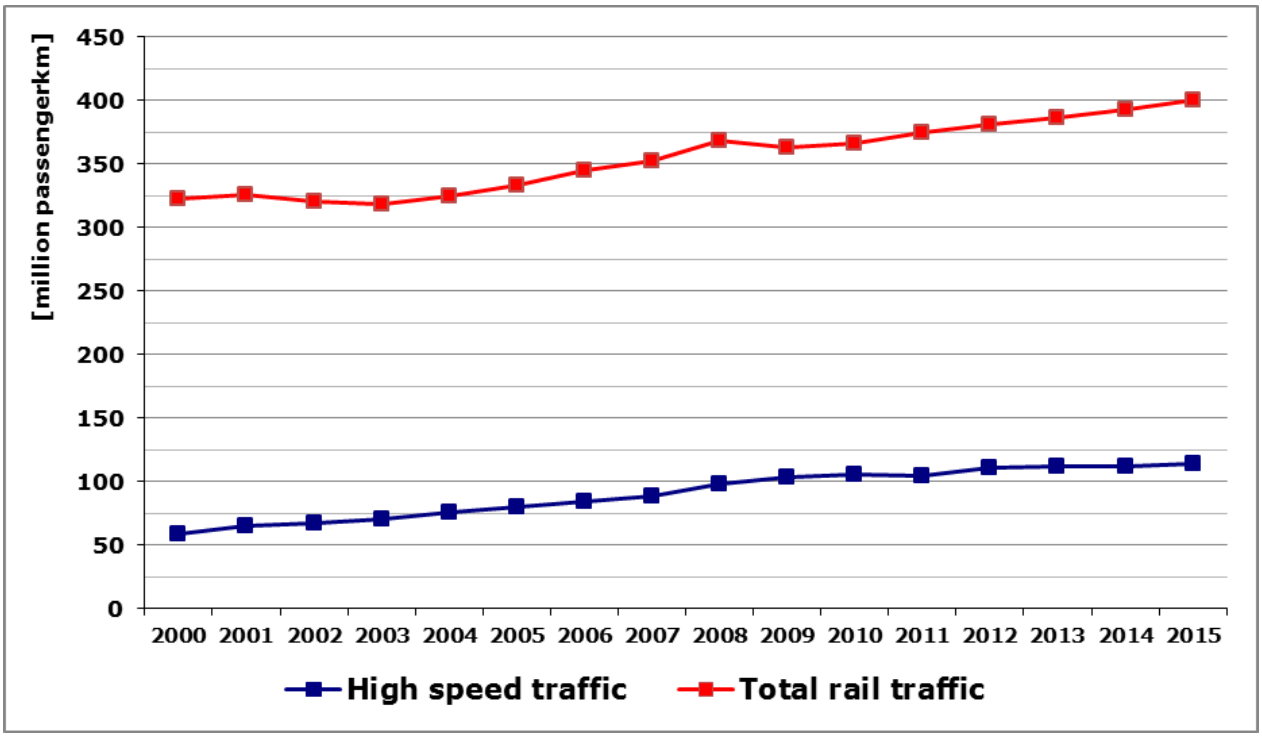
Sweden and the UK rail is used more than buses and coaches, probably thanks to a wider set of services at the urban/suburban level.

To better understand the evolution of passenger demand over recent years, it is worth distinguishing the trend relating to high speed rail services, where large investments have been completed, compared to other rail services. Figures indicate that the volume of passengers travelling by high speed railway has increased significantly from 2000 to 2015. This generally positive trend was not adversely affected by the economic crisis, as was the case for the total number of rail passengers (please see Figure 8 below).

In 15 years, the volume of passengers using high speed rail has nearly doubled, from 58.6 to 113.7 million of p-km (i.e. an increase of 94.1%). The highest increase (i.e. 78.2%) happened between 2000 and 2011, when the high speed rail network was extended from 2 707 to 6 807 km, whereas the increase was smaller between 2011 and 2015, i.e. only 8.9%, after the completion of an additional 1 368 km.

Notably, with respect to the total number of rail passengers, the share of those travelling by high speed trains has increased from 18.1% to 28.4% between 2000 and 2015. In the Member States that have high speed infrastructure for commercial speeds over 250 km/h, France and Spain have the highest share of rail passengers using high speed rail (i.e. 56.1% and 53.8% respectively), which is around twice that of Germany and Italy (i.e. 27.7% and 24.5% respectively), while Belgium, the Netherlands and the UK are all below 10%.

Figure 8: Total volume of rail (and high speed rail) passengers in the EU

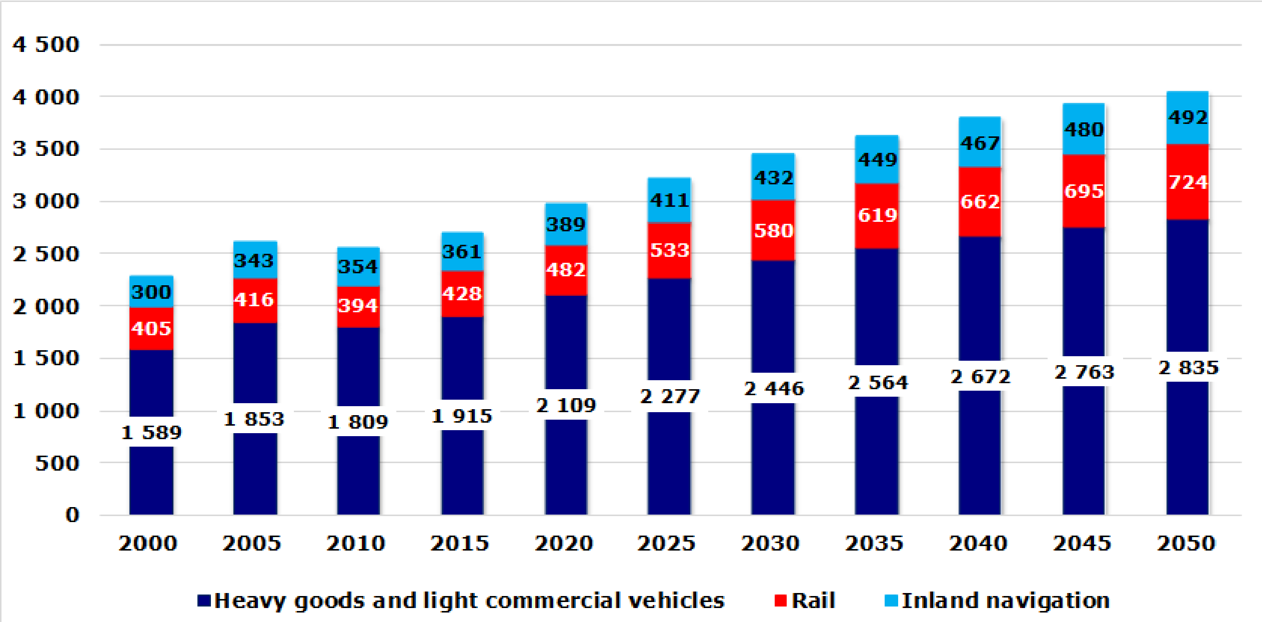


Source: Authors' own elaboration based on Eurostat and UIC

2.1.3. Projected demand and modal shares for 2030 and 2050

The Commission's Directorate-General for Energy (DG ENER) reference scenario published in 2016 provides the most recent updated trend projections about the future of transport sector in the EU. The report focuses on the EU energy, transport and greenhouse gas (GHG) emission projections, and on the cross-cutting interactions between different policies in these sectors. It starts from the assumption that the policies agreed at the both EU and Member States level by December 2014 have been implemented and that the legally binding GHG and renewable energy systems (RES) targets for 2020 will be achieved. On this basis, volumes of both passenger and freight transport are expected to increase, although their growth is anticipated to slow down after 2030 (please see Figure 9 below).

Figure 9: Projected freight transport demand – EU-28 reference scenario (billion t-km)

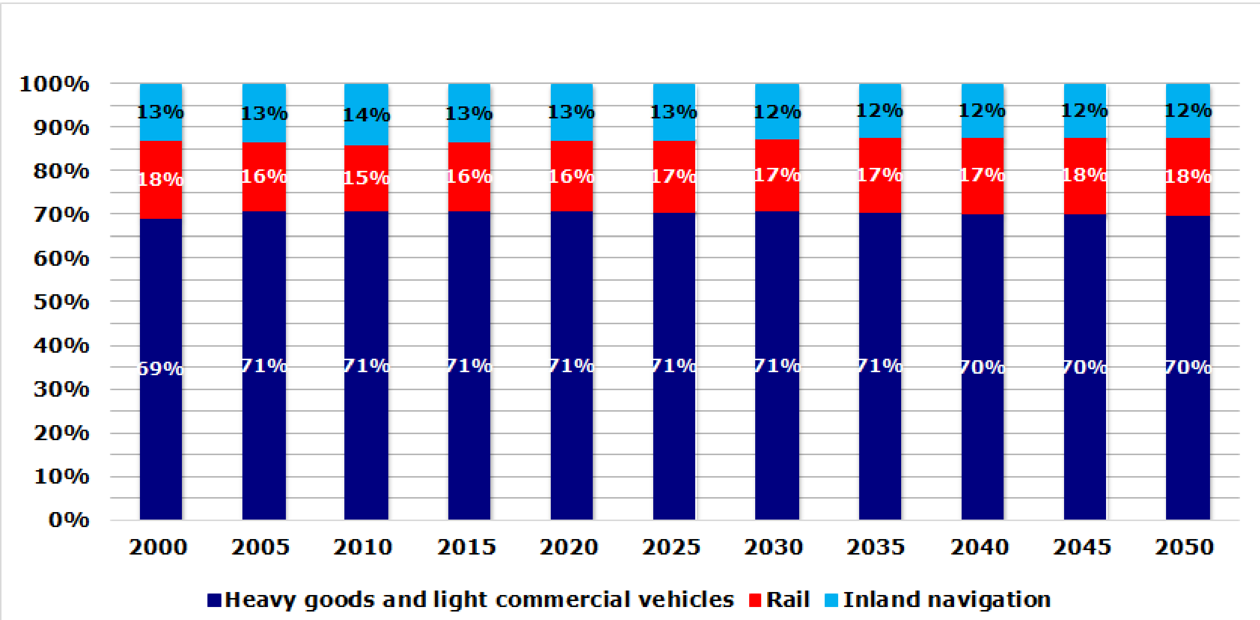


Source: EU-28: Reference scenario (Capros et al., 2016)

Road transport is expected to maintain its predominant position over rail and IWW, with a projected 57% increase in volumes transported for the period 2010-2050. The growth is projected to be more significant in EU-13 countries, than in the EU-15 Member States (please see Figure 10).

Rail freight traffic is expected to account for the largest percentage increase in volumes transported (84% between 2010 and 2050), which would result in its modal share increasing from 15% to 18%. Such an increase would be mainly driven by the scheduled completion of the TEN-T core and comprehensive networks, which is foreseen to experience the lowest increase in volumes, of only 39% in the 2010-2050 timeframe, which means that its modal share would slightly decrease.

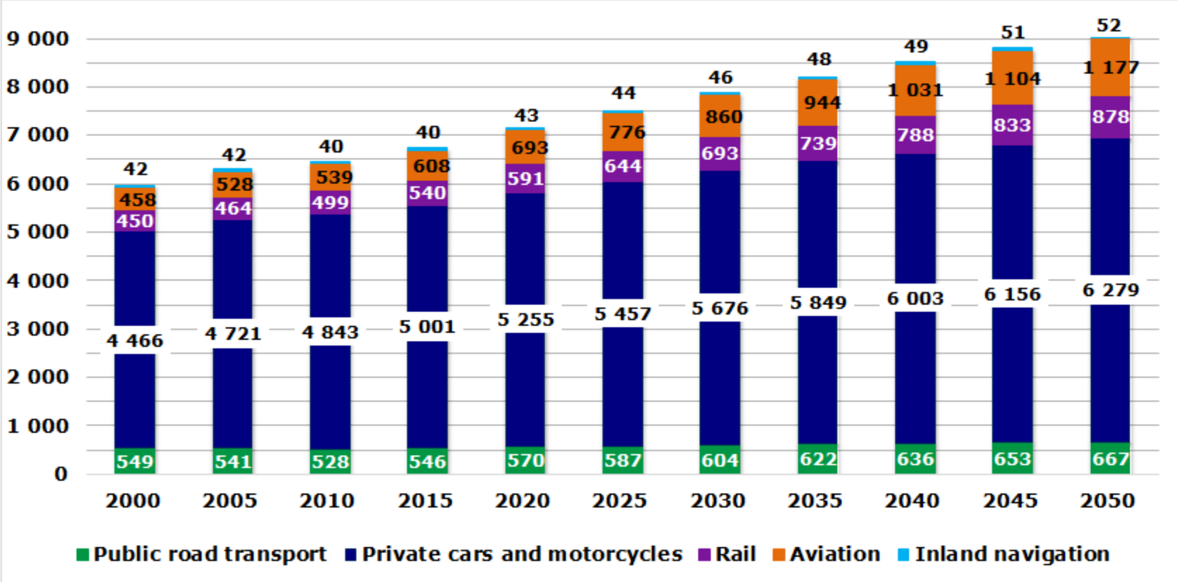
Figure 10: Forecasted freight transport – EU-28 reference scenario (% based on t-km)



Source: EU-28: Reference scenario (Capros et al., 2016)

The projected increases in the demand for the various modes in the passenger sector are shown in Figure 11.

Figure 11: Forecasted passenger transport – EU-28 reference scenario (billion p-km)



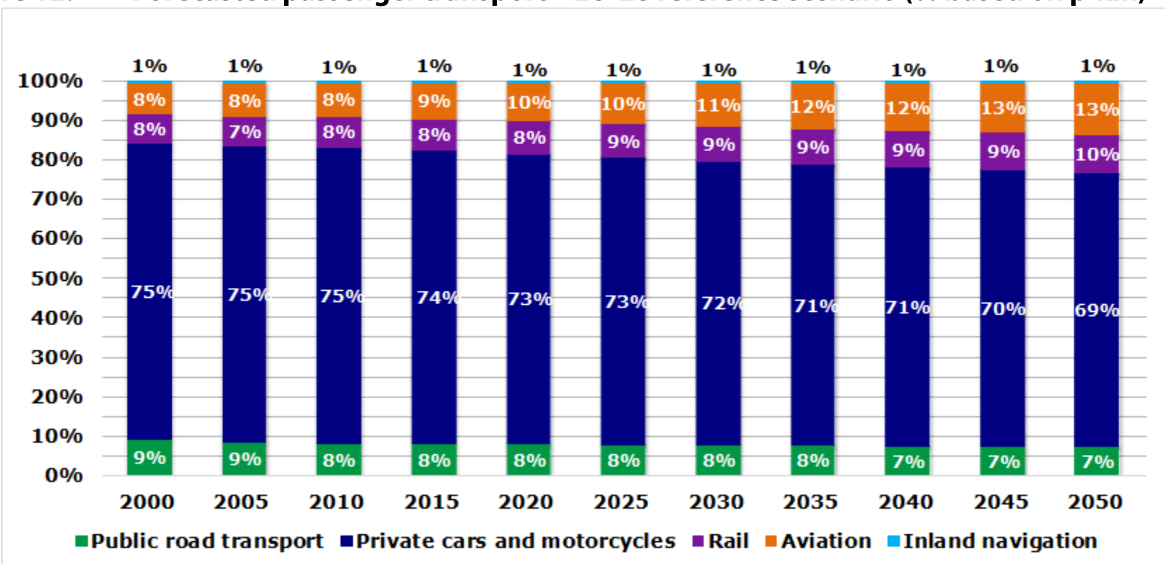
Source: EU-28: Reference scenario (Capros et al., 2016)

Road private transport is expected to keep its dominant position even if its modal share is expected to decrease (from 73% in 2020 to 69% in 2050). This reduction is anticipated as:

- car ownership rates are close to saturation in the EU-15 Member States;
- the price of fossil fuels is expected to increase in the long term;
- congestion in urban areas is growing; and
- the EU population is ageing.

Thanks to the gradual completion of the TEN-T network, the additional high speed rail (HSR) infrastructure and the revamping of some existing lines, rail passenger transport is expected to grow by 76% by 2050, compared to 2010, corresponding to an increase in modal share from 7.7% to 9.7%. Air transport is projected to register the highest growth of all transport modes, as the total number of passengers is projected to more than double by 2050 (i.e. increase by 125%) compared to 2010. The overall growth in demand for passenger travel is expected to be more significant in the 2010-2030 period and in the EU-13 countries.

Figure 12: Forecasted passenger transport – EU-28 reference scenario (% based on p-km)



Source: EU-28: Reference scenario (Capros et al., 2016)

2.2. Demand and transport modal choice

In order to understand modal shift and to be able to identify potential measures that could bring about a modal change, it is important to understand the factors that drive modal choice. In broad terms, modal choice can be identified as the result of the decision process to choose between different transport alternatives.

Modal shift means a switch from a given transport mode to another, as a result of a modified choice. Technological evolution was historically the main driving factor that made transport systems change and evolve over time. Even if the transport industry is now much more complex than in previous centuries, the mechanism underlying modal shift remains the same: when a transport mode becomes more advantageous than another (for various reasons, in terms of costs, convenience, quality, speed or reliability) over the same route or in the same market, a modal shift is likely to take place.

Modal choice is a very complex decision process, determined by a wide range of factors coming from different disciplines, such as economy, sociology, geography and psychology. It is often the result of a complex process that can take place consciously or unconsciously and which includes both objective and subjective determinants. Objective determinants can typically be identified quantitatively, while subjective ones are qualitative (De Witte et al., 2013).

The following paragraphs illustrate the main factors driving modal choice, distinguished by passenger and freight transport.

2.2.1. Passenger transport

Three kinds of determinants play a decisive role for an individual in choosing which passenger transport mode to use, i.e.:

- Socio-demographic factors (age, gender, education, occupation, income, population density, household composition, car availability);
- Journey characteristics (reason for travel, distance, travel time and costs, departure time, trip chaining, weather conditions, information, interchange availability);
- Spatial patterns (urban and rural density, diversity, proximity to infrastructure and services, frequency of public transport, availability of parking).

Socio-demographic factors

Car availability is probably the most important factor in determining modal choice. The availability of a private means of transport, in particular a car, influences the way people move. It allows people to make choices involving locations that would not be practical without the use of a car, particularly for those who live in peri-urban environments.

In the EU-15, the motorisation rate had been growing constantly in recent decades, until recently, when there have been concrete signs that it has been beginning to level off or even slightly decrease, due to several reasons (market saturation, economic crisis, more stringent measures against car use in urban areas, etc.). Conversely, the EU-13 countries, which have generally experienced lower levels of income and car ownership in recent decades, are showing a growing rate of motorisation[9].

[9] In 2016, there were on average 587 vehicles per 1 000 inhabitants in the EU. In some countries, such as Greece, Germany, Spain, Estonia, Austria, Poland, there were more than 600 vehicles per 1 000 inhabitants, while in Italy, Malta, Cyprus, Finland and Luxembourg, there were more than 700 per 1 000 inhabitants, with Luxembourg being at the top of the ranking (ACEA, 2016).

Other key factors are:

- **Household size**. As the household size increases (and particularly the number of children increases), the chances are higher that the members of the family travel by car.
- **Occupation**. Freelance professionals and business travellers tend to be more attracted and inclined to use private means of transport, while employees working for medium to large companies tend to use public transport more.
- **Income levels**. Higher incomes provide wider transport choices and options. Literature seems to converge to the fact that income has a positive relationship with car use and ownership (Hensher and Rose, 2007). People with lower incomes pay much more attention to their travel costs and make their decisions according to this criterion, thus having a reduced range of travel options.

Gender also affects modal choice, as women and men use transport modes differently. Women are more likely to travel shorter distances than men, undertake more non-work travel outside the rush hour and make more multi-stop journeys, e.g. running household errands and accompanying other passengers, usually children or elderly persons (IRS-TRT, 2012). Compared to men, they are more likely to use more sustainable transport modes, preferring public transport.

Journey characteristics

It is widely recognised that travel time and cost are the two elements of the transport supply that determine an individual's modal choice. Although they are not the only decisive factors, it is rare that an alternative with a significantly higher cost and travel time is considered.

Travel time has a direct impact on modal choice, not only the total travel time but also different components of the journey impact on the modal choice. For example, the time taken to access or to wait for a train or bus is considered much more unpleasant than the time spent on board the same train or bus.

Availability of the services is also affecting modal choice. Public transport services are often not as frequent off-peak, whilst the provision of less frequent service levels overnight also seriously affects the potential of travellers to use alternatives to the car.

Other factors include safety concerns especially when travelling late and in specific districts and/or along lines located in the largest urban agglomerations.

In general, when a trip is made for recreational purposes, departure and arrival times are more flexible, and so it is easier to find more attractive and tailored travel options. However, for home-to-work or home-to-school trips, there is less flexibility, so people normally have to travel in peak hours. Chances are high that these trips are undertaken in less comfort, higher congestion and will take longer.

The need for trip chaining – trips including at least one intermediate stop – also has an impact on modal choice. Complex trip chains tend to be more car-oriented and, in general, the more complex and extended (in terms of time and distance) a trip chain is, the more private transportation means are preferred, compared to public transport. In fact, there is a general resistance amongst users to switch between different transport modes on the same journey, and this affects public transport in particular.

Weather conditions – coupled with the topography of the territory (e.g. flat or hilly) – can encourage or discourage people to undertake trips by bicycle or by foot, or with public transport. However, evidence seems to suggest that weather conditions are a marginal factor for modal choice. As an example, looking at the modal shares of some North European countries such as Denmark or the Netherlands, it is noticeable that the number of urban trips made by bike is considerably higher than those occurring in similar-sized cities located in southern European countries like Italy or Spain.

Spatial patterns

An important determinant for short distance trips, particularly at the urban scale, relates to the spatial-temporal pattern of mobility.

Population density is the most relevant indicator used to measure the concentration of population in a given area. Two factors can be highlighted: almost three quarters of EU-28 citizens live in urban areas; and this proportion is expected to further grow in the next decades (Eurostat, 2016). The population density differs greatly across the EU, ranging from a highly urbanised country like the Netherlands, to more rural and scattered population settlements typical of several eastern European countries.

Urban density is a key factor for modal choice: urbanisation allows higher densities, concentrating human and economic activities in a limited space. Generally, shorter trips can be undertaken more easily with public transport or the soft modes[10] where the urban density, in terms of people per square kilometre, is higher. Further to the traditional public transport services, cities have been experimenting and developing new and innovative mobility schemes in more recent years, and have become keener to promote smart-mobility concepts (such as bike, car and scooter sharing, Mobility as a Service or "MaaS", etc.). On the other hand, urban sprawl and the lower density of peri-urban areas make the use of private motorised vehicles much more convenient, since it becomes difficult for public transport to compete in terms of time and availability; as a result, there is lower demand for public transport.

The **proximity to infrastructure and services** also plays an important role in modal choice. The location of a household, a workplace, or any other kind of activity close to a public transport stop (rail or underground station, bus or tram stop, etc.) increases its overall accessibility, thus reducing travel times, and influences users in their day-by-day transport choices. This is valid in metropolises, but can also be a determinant of modal choice in suburban and rural environments, where, for longer trips, a public transport stop can connect more remote areas by bringing together demand from a larger area.

The **frequency** of public transport services is generally high or very high in larger metropolises (e.g. one/two minutes wait during peak hours in Paris or London undergrounds). Conversely, when cities and urban agglomerations are smaller, the frequency of public transport declines in line with transport demand, making private means of transport more competitive.

Finally, the presence and **accessibility of parking areas** is a further aspect that incentivises car use. Easily accessible, comfortable and free parking areas are generally available in suburban, peripheral and rural areas, where drivers have little difficulty in parking their vehicles. Quite the opposite often happens in urban areas, where the availability of parking zones is progressively being reduced, and the competition for space is increasing.

The previous assumptions made on modal choice determinants are generally valid not only for urban trips, but also for **medium and long distance travels**. Even if in this sense the literature available on key determinants is smaller than the one focused on urban areas only, the impact of socio-demographic and land-use variables on travel behaviour is relevant also outside urban areas (Gonzáles and Suárez, 2013). A study carried out on medium and long distance travels in Spain highlighted that socio-demographic variables like gender, age and income play a significant role on mode choice also on longer distances. The evidence coming from the study shows that higher income levels also reduce the use of public transport means over private car. Among the other findings, a longer duration of inter-city trips appears to favour the use of railway mode while reducing the demand for bus.

[10] Soft modes refer to non-motorised, less polluting and more efficient modes of transport, such as walking and cycling.

2.2.2. Freight modes

The nature of freight transport has evolved over time: goods have been carried more and more over longer distances and to and from overseas destinations, while at the same time smaller and more frequent deliveries of goods have increased as well. The evolution and development of e-commerce and digitalisation on a mass scale are contributing to reshaping logistics and supply chains.

A wide and comprehensive literature has been produced in recent decades, detailing the reasons and factors that play a decisive role in the freight modal decision-making process. The choice of mode is a fundamental decision taken by shippers and freight forwarders when they plan to transport freight. Decisions made by shippers are a function of the characteristics of their previous experience, the type of goods to be carried, the carriers' attributes and distance/time requirements, as well as the price. In fact, where businesses have committed to road-based logistics, it can be very difficult to persuade them to switch to rail or to waterborne transport (Steer Davies Gleave, 2015a). Even if carriers generally organise the movement of consignments from shippers to receivers, their decisions about using intermodal services are constrained by shippers' preferences, and thus shippers can be seen as the principal decision-makers affecting the demand of intermodal services (Patterson et al., 2008).

The approach followed by Patterson et al. (2008) and Samimi et al. (2010) divides the factors contributing to modal choice for freight transport between shipper and shipment attributes, geographic and time characteristics, and carrier attributes.

Shipper and shipment attributes

Shipper attributes include firm size, accessibility to rail/road/IWW network, and custom and practice among decision-makers in shipping companies. Shipment attributes include the type of goods being transported, their density (in terms of weight per unit of volume) and value per unit of the product being transported, their degree of perishability and shelf-life, and their packaging characteristics (Steer Davies Gleave, 2015a).

The density of road transport networks increased almost everywhere in the EU during the 20th century, to the detriment of rail and waterway networks. The construction of motorways facilitated the "realignment" of the space economy to the road network; nowadays, only a small proportion of industrial facilities is located close to rail or canal networks (McKinnon, 2018). As an example, a survey of 2 809 warehouses in Germany revealed that only 180 (6.4%) had direct rail access (Rolko and Friedrich, 2017). Therefore, to access rail and waterborne services additional road feeder movements are needed, adding to door-to-door delivery times and increasing costs, so making these alternatives less convenient.

Geographic and time characteristics

Temporal factors play an important role for modal choice, such as the distance covered and the flow rate. Rail and waterborne services are generally slower than trucks, thus making the latter a more attractive option for more time-sensitive and higher value goods (McKinnon, 2018). The European Court of Auditors estimated that goods moved across the EU by rail travel at an average speed of 18 km/h (European Court of Auditors, 2016).

For all distances below 200 km, road transport mainly enjoys a time-related advantage over other modes; the shorter the travel time, the more important time becomes relative to cost (Danielis et al., 2005). Moreover, the competitiveness of rail decreases due to a lack of flexibility on timetabled routes, since all of the movements are networked and they must adhere to specific paths allocated by the infrastructure managers, at given times. This is quite in contrast with the freedom and flexibility of road-based transport, which is able to synchronise freight movements much better with productivity and warehousing operations. Road transport is also more flexible in servicing just-in-time deliveries and operations.

Carrier attributes

Operational factors complement the above-mentioned reasons that determine freight modal choice. Some types of goods are intrinsically better transported by certain modes. For example, great quantities of heavy bulk goods (e.g. coal, metals, chemicals, etc.) are predominantly transported by rail or waterborne transport as they need to exploit their scale economies. Trucks are better suited for smaller quantities, which are mainly composed of manufactured and containerised goods. The lack of interoperability between the railway systems of different countries or between rail freight companies (further discussed in section 3.1.5) makes the use of rail more complicated and reduces the effectiveness of rail's long-haul advantage. This is particularly true in Europe, where differences relating to signalling systems, loading gauges, locomotive power ratings, wagon coupling etc. are still widespread across the continent.

According to a study carried out for the European Commission, 11 service characteristics can be identified as being decisive for modal choice, particularly between road transport and intermodal transport (RAND Europe, 2003). Table 5 lists and briefly describes all of these.

Table 5: Criteria considered when choosing intermodal services over road transport

	Characteristics	Description
1	Cost	Is transport cheaper or more expensive than by road?
2	Travel time	Does it take longer or is it quicker than road transport?
3	Reliability	Is it more or less reliable than road transport (in terms of the length and frequency of delays)?
4	Flexibility	Can it quickly adjust to changes in demand and in customer requirements?
5	Tracing of freight	Can the location and status of load units and cargo be checked easily?
6	Use of infrastructure	Is the quality and capacity of the infrastructure (including terminals) sufficient?
7	Scale/volume	Is it better or less able to handle large volumes of goods than road transport?
8	Service of terminals	Do the services provided at terminals give the mode that uses these terminals an advantage over road transport or do they make it more cumbersome?
9	Legislation	Does the mode have legal advantages or are there legal bottlenecks that road transport can circumvent?
10	Safety	Do load units and cargo incur more or less damage than in road transport?
11	Security	Are goods better or worse protected in intermodal transport?

Source: Van de Riet et al. (2007)

3. OVERVIEW ON THE PROGRESS: NETWORK DEVELOPMENT, POLICY AND REGULATORY ISSUES

KEY FINDINGS

- The density of rail and IWW networks differs across the EU, as does the provision of ports and intermodal terminals. Therefore, **multimodal connectivity within Member States and their regions is diverse**, with the highest connectivity seen in the Benelux area and western Germany.
- The levels of **completion of the TEN-T core network are low** for road and conventional rail, and even lower for the high speed rail network.
- Regarding **high speed rail**, the most extensive networks are in **Spain** and **France**, followed by **Germany and Italy**.
- **Cross-border interoperability** in the rail sector is still **far from being fully achieved**, as many technical and administrative barriers are still present on the ground. Road and IWW are more interoperable, largely as they do not face the same levels of complexity in making infrastructure interoperable.
- Different access **charging schemes** are applied across EU roads, both for light private vehicles and heavy goods vehicles (HGVs). These include distance or time-based charges and tolls applied in specific sections of the network.
- In the **rail sector**, access **charges are differentiated by train type**, the location of the line or node in the network and the time of the service provided. Access charges for high speed rail are higher compared to those applied to conventional rail services.
- Handling accounts for the majority of the port dues, which are effectively the access charges for the use of port infrastructure. **Environmental based fees are receiving increasing attention**.
- In **IWW**, in general, **low access charges** are applied, which only cover a low proportion of the total expenditure on the infrastructure. **Handling dues are higher**.
- **Multimodal information, management and payment system (MIMP)** systems and multimodal payment and ticketing systems are being developed to enable access to updated and reliable information on public transport services, especially in urban areas. Several examples and best practices have been implemented, while many different technologies are currently being used.
- **In freight transport**, the importance and the need to establish a Single Window (single access point) and one-stop-shop for administrative procedures in all transport modes has been recognised by several bodies and policies. The **actual implementation at the EU level is mainly focusing on the maritime and rail** sectors, even though the efforts in the latter sector have not been fully effective, so far.
- Urban areas, part of the TEN-T since 2013, are attracting a growing share of demand for passenger and goods. They are often the prime location of intermodal interchanges, as are **train and bus** stations and airports. This requires **integration across a range of elements,** physically at specific location, timetables information and ticketing.
- **Integration between modes can be improved through the use of technology**, such as mobile phone applications for travel planning and payment systems.

This chapter analyses specific progresses made in the EU transport system in fields that are deemed to favour a better integration between modes and to push towards a more tangible modal shift.

- Section 3.1 analyses the progress made in terms of connectivity of multimodal transport infrastructure, including as key areas the progress made in the development of TEN-T corridors and high speed railways;
- Section 3.2 sets out how access charges are levied for different types of transport infrastructures, as well as the level of these;
- Section 3.3 focuses on the state of play in the field of electronic information in transport;
- Section 3.4 is devoted to an analysis of relevant developments in urban areas;
- Lastly, section 3.5 provides an overview on the EU financing of multimodal projects.

3.1. Network development: quality, density, multimodality and interoperability

This chapter provides an overview of the infrastructure in the EU, with a focus on rail transport. It mainly focuses on the most relevant transport corridors, such as the TEN-T network, highlighting the state of play in relation to the development of the nine corridors and also looks forward to their potential completion. Consideration is then given to the implementation of high speed railway lines and the nature of rail freight corridors across the EU, considering their potential to shift more passenger and freight traffic from road to rail. Further aspects such as the level of multimodality and interoperability of the different transport modes are also discussed, including how they affect modal shift.

3.1.1. Density and location of rail, IWW and intermodal infrastructure

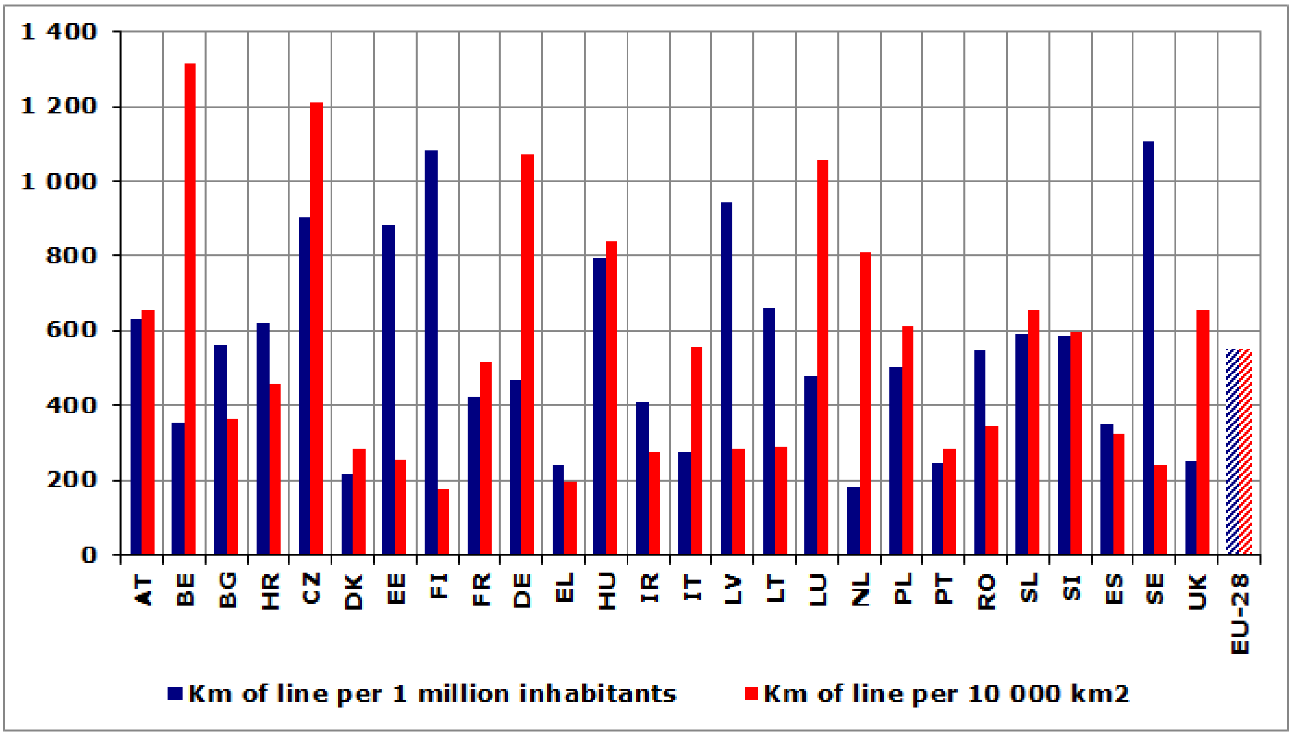
In the context of spatial development, the quality of transport infrastructure, in terms of its capacity, connectivity, travel speeds, etc., determines the competitive advantage of locations, which is usually referred to as their accessibility. Investment in transport infrastructure leads to changes in the qualities of different locations and may induce alterations in spatial development patterns (Spiekermann and Wegener, 2005). Geographical position, the availability of infrastructure and the strength of the economy are the three key elements which describe the pattern of the EU overall accessibility and connectivity.

Multimodal logistics refers to when freight is moved by combining two or more transport modes. Today, multimodal freight transport plays a significant role in the overall supply and distribution chain. The advantage of multimodal transport lies in the ability to utilise the most efficient combination of multiple means of transport. The combination of these should also result in increased environmental sustainability. The contribution of multimodal mobility is relevant also for passengers, who can benefit of quicker and improved connections, especially at urban level and within specific transit nodes.

The road network has a widespread distribution across the EU, comprising an extensive network composed of roads of different categories and importance. The eastern EU Member States, as well as Spain and Ireland invested particularly in the extension of their road networks by building new motorways in recent years (Eurostat, 2018). As seen in the previous chapter, the growing trend of road freight transport in some Eastern EU Member States has been more significant than the EU average, being the provision of new road infrastructure likely to have contributed to this trend. In any case, an infrastructure gap is visible at all levels between EU-13 and EU-15 Member States, as well as differences occur at regional level in all EU macro areas and in proximity of largest metropolitan zones.

A closer look at the density of the rail and inland waterway networks provides interesting insights into the availability and accessibility across the EU of the modes that have the potential to attract freight transport away from road. Central Europe has the densest rail network, with Belgium, the Czech Republic, Germany and Luxembourg at the top of the ranking, with values higher than 1 000 km per 10 000 km^2 (please see Figure 13). When considering the density per number of inhabitants rather than the land surface as a comparative parameter, Finland, Sweden, Latvia, Estonia and the Czech Republic have the densest networks.

Figure 13: Rail network density in the EU-28 by Member State



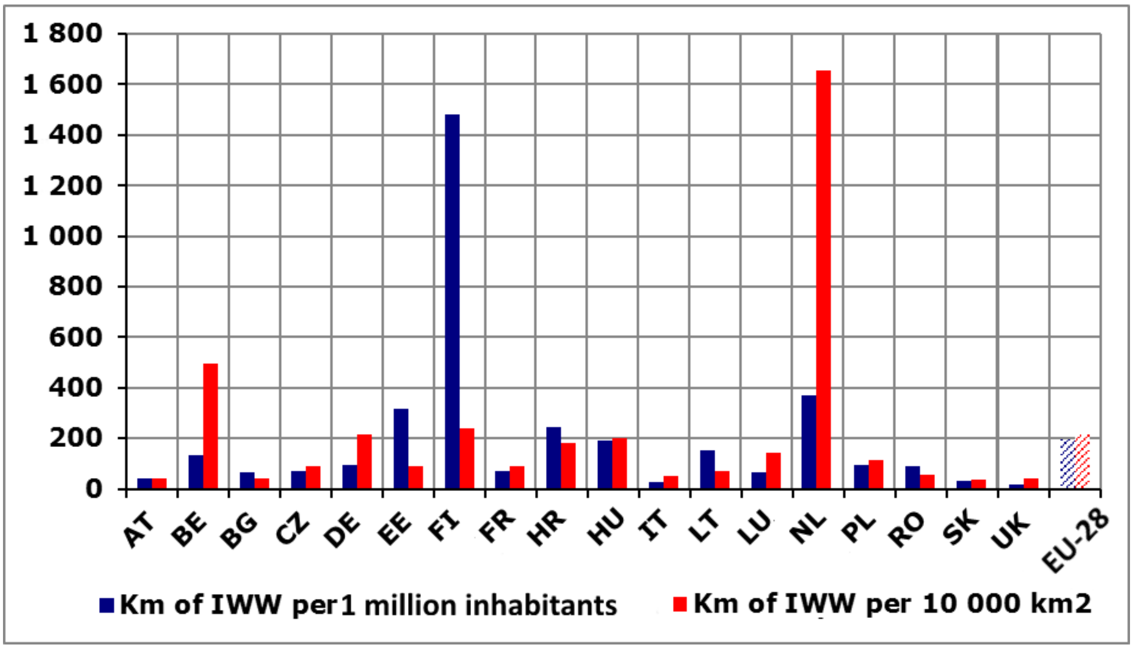
Source: Authors' own elaboration based on Eurostat data

The rail network is the densest in the most industrialised zones and strongest economic areas, as well as in the most significant urban areas. Germany, France, and then respectively Poland, Italy and Spain, have the most extensive rail networks (measured in km). These countries are also the most populated (together with the UK) and have the largest areas amongst all Member States.

It is worth to highlight that the rail density and overall geographical distribution of the rail infrastructure among EU Member States is not enough to justify the use of rail facilities. In fact, the performance of the rail services and operators is to be considered a more relevant factor capable to favour a shift of transport volumes and passengers from road to rail.

The Netherlands leads the EU ranking as far as the density of the IWW network is concerned (please see Figure 14 below), which is notable given that the country also has the highest modal share for IWW in the freight transport market (please see also Table 1 in section 2.1.1). Belgium, Germany, Hungary and Finland follow in the ranking as far as IWW density is concerned, although all with a much less dense network. Due to its high number of lakes, Finland has by far the longest network compared to its population, although navigation is not practicable in all seasons due to weather conditions. Several southern Member States, such as Spain, Portugal and Greece, do not have any suitable infrastructure for inland navigation.

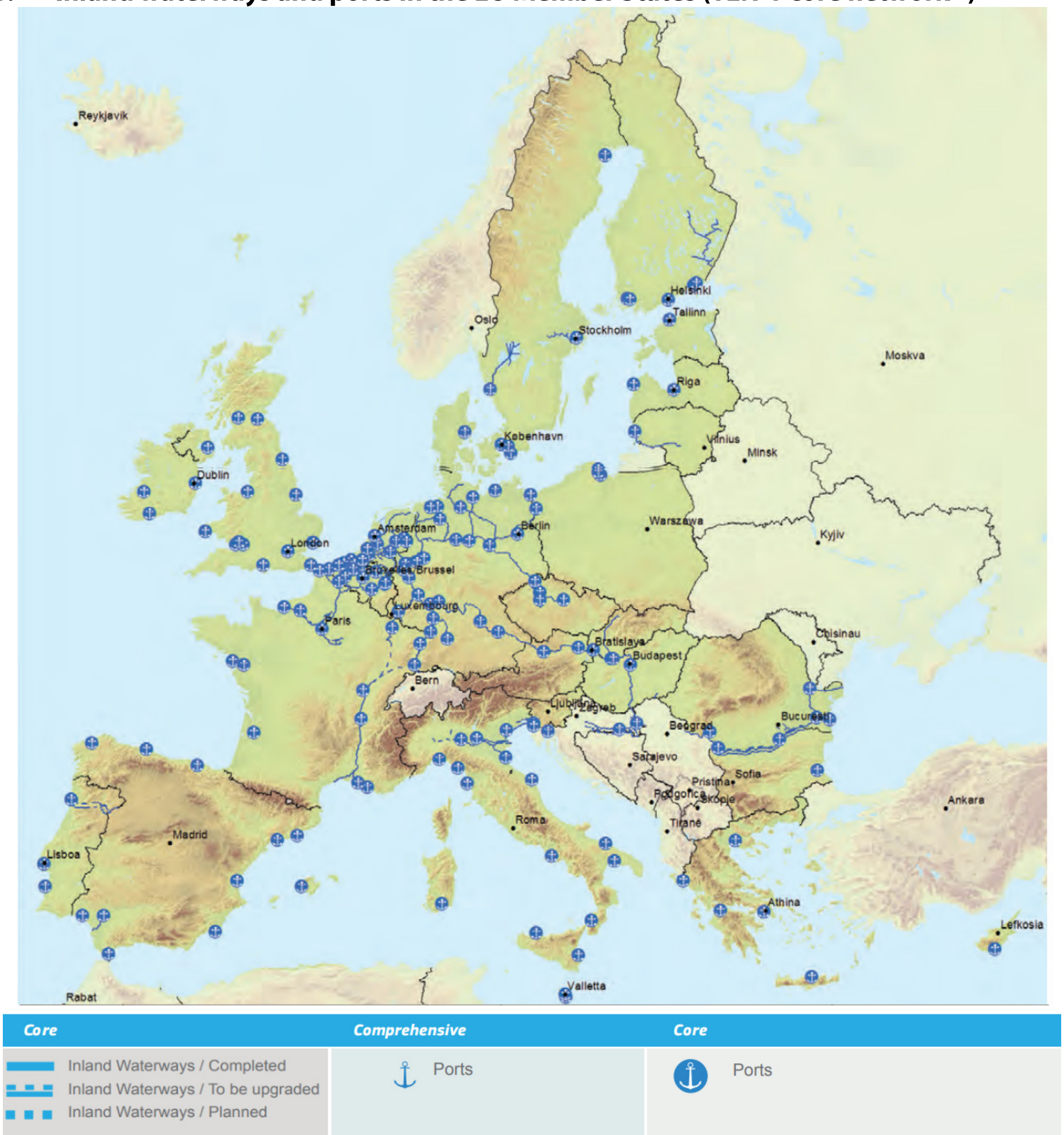
Figure 14: Inland waterway network density in the EU-28 by Member States



Source: Authors' own elaboration based on Eurostat data

Currently, the Rhine, Danube, Scheldt, Elbe and Oder river basins are interconnected with canals; together, these rivers form the most important inland waterway network in the EU. Considerable improvements and enhanced connectivity to France will be achieved once the Seine and Rhône river basins have also been connected to the main European network. In particular, the construction of the Seine-Nord Europe Canal in northern France will connect the Seine River with the canal system of the North Sea ports of Antwerp and Rotterdam, as well as the German waterways. Once completed, the canal should provide a more sustainable and potentially cost-efficient import/export gateway between Paris, northern France, Belgium and the North Sea ports. Map 1 below shows the current extent of the inland waterway network and the location of the main ports across the EU-28.

Map 1: Inland waterways and ports in the EU Member States (TEN-T core network[11])



Source: European Commission's TENtec portal

Intermodal terminals are the interface between the different transport modes and thus are key to accessing intermodal transport services and to ensuring efficient intermodal supply chains throughout the EU that are competitive with roads. In order to identify the potential for modal shift, it is worth having a closer look at the nodes and the most relevant infrastructure that could play a role in shifting part of road freight to more sustainable modes of transport. An analysis of the occurrence of the types of last-mile infrastructure in the EU provides interesting results concerning the potential for multimodality. At first, the number of dedicated types of last-mile infrastructure suggests the importance of rail freight in EU.

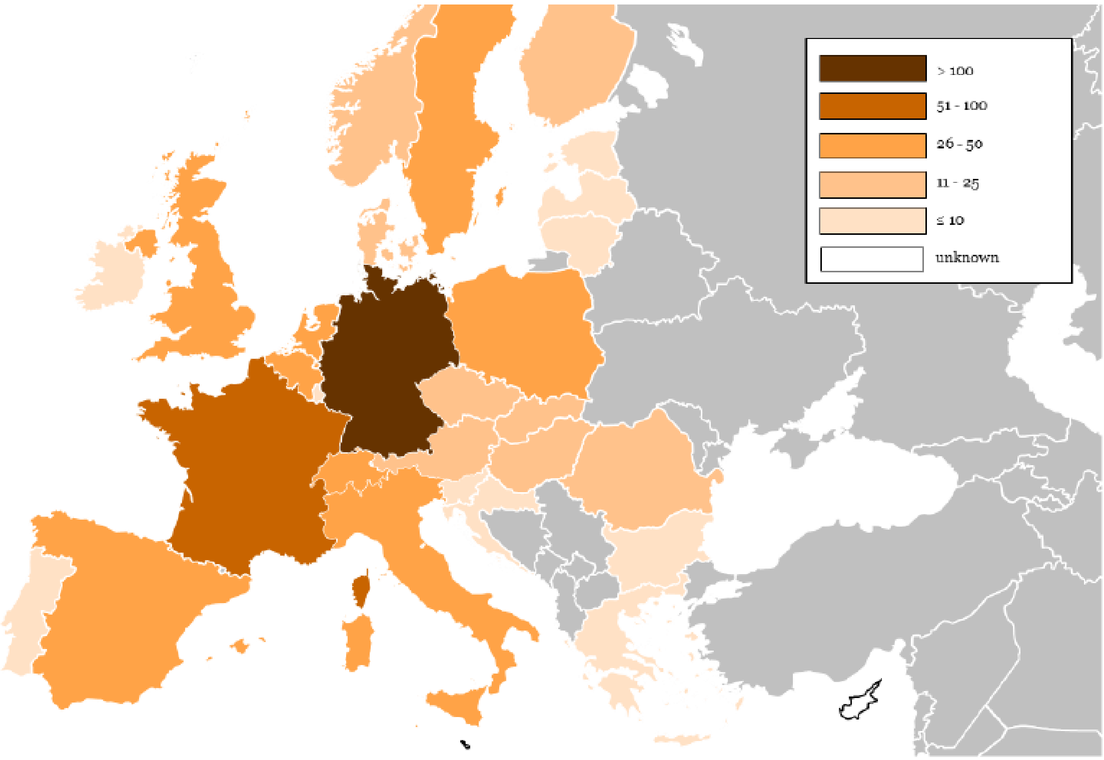
[11] The "core network" is a part of the comprehensive network, distinguished by its strategic importance for major European and global transport flows. It results from a single European planning methodology. Developed by the European Commission and subjected to broad consultation among Member States and other stakeholders, it is the first method of its kind. The total length of the core network amounts to 50 762 km of railway lines, 34 401 km of roads and 15 715 km of inland waterways (Source: the European Commission's DG MOVE).
The "comprehensive network" is a multi-modal network of relatively high density which provides all European regions (including peripheral and outermost regions) with an accessibility that supports their further economic, social and territorial development, as well as the mobility of their citizens. Its planning has been based on a number of common criteria (e.g. volume thresholds for terminals or accessibility needs). The total length of the comprehensive network amounts to 138 072 km of railway lines and 136 706 km of roads (source: European Commission's DG MOVE).

A study conducted by the European Commission in 2016 provides an overview of the occurrence of four main types of last-mile infrastructure (European Commission, 2016a). The total number of pieces of all last-mile infrastructure showed a significant development in nearly all EU Member States in recent years. Even though the number of private sidings and stations with public sidings have decreased, the number of intermodal terminals and rail-ports/conventional terminals is increasing.

In total, some 15 600 private sidings[12] were identified in the EU and Switzerland, nearly half of which were located in Germany, Poland, France, Switzerland and the Czech Republic. In contrast, low numbers were identified in southern and south-eastern Europe (European Commission, 2016a). The number of private sidings in the EU is decreasing, and it seems to be an irreversible trend: as an example, in Germany the amount of private sidings fell from about 13 000 in 1993 to 2 400 in 2013. This is mainly due to the fact that single wagonload traffic faces challenges in many countries in Europe in terms of its profitability and quality; it also has difficulties keeping pace with changing market requirements (Guglielminetti et al., 2015). In the future, it is anticipated that large existing private sidings will be used more extensively than today, whilst smaller facilities will be abandoned.

On the contrary, the role of intermodal terminals and in particular rail-port terminals is expected to grow further. Germany has most terminals, with some 150 terminals accessible by rail, followed by France, Belgium, Italy, the Netherlands, Poland, Sweden, the UK and Spain (please see Map 2 below). In total, all EU Member States (as well as Switzerland and Norway) had at least one intermodal terminal, totalling about 730. The majority of inland intermodal terminals are located along the main fluvial axes, such as the Rhine, the Danube, the Elbe, the Seine and the Rhône Rivers.

Map 2: Intermodal terminals with rail access – occurrence in Europe



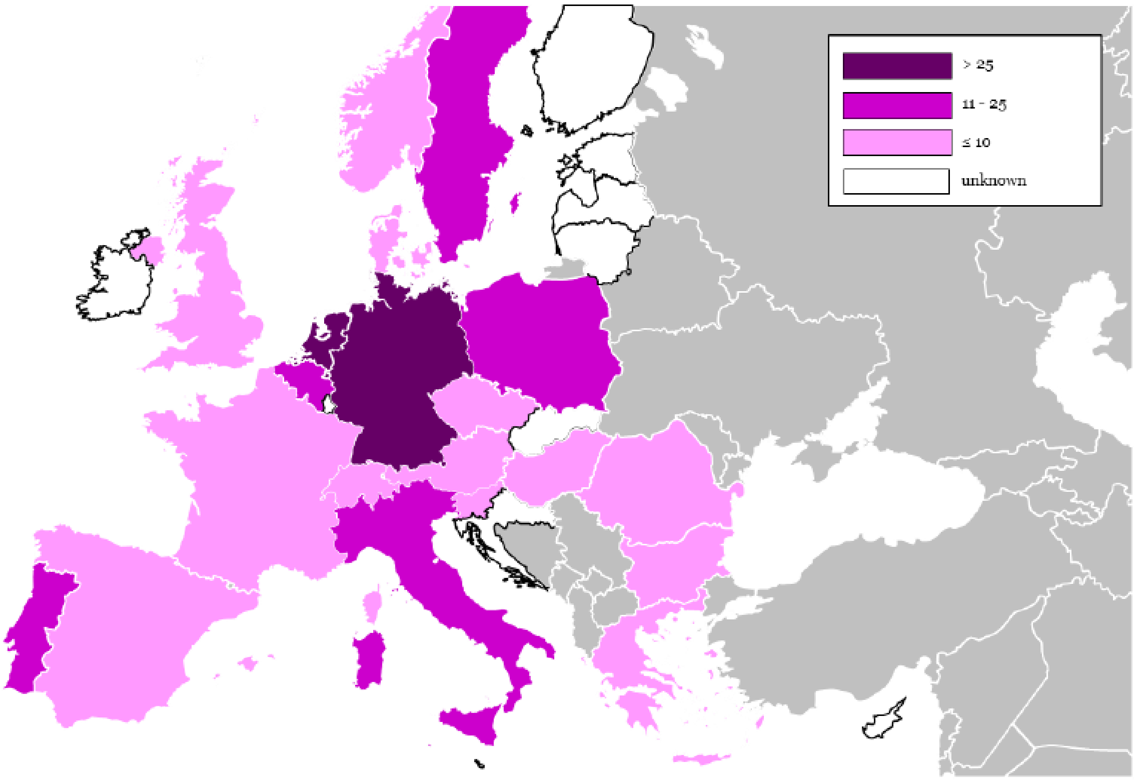
Source: HaCon based on Studiengesellschaft für den Kombinierten Verkehr (SGKV data).

[12] Private sidings are privately owned and operated sections of rail infrastructure, connecting loading facilities (which are not part of the rail infrastructure) to the public rail network. The layout configuration depends on the individual requirements of the respective customer. Sometimes several private sidings are connected to a feeder track, which in turn is connected to the public network (European Commission, 2016a).

Rail-ports terminals are intended to (partially) balance the volume losses of single wagon transport[13]. Moreover, these facilities offer additional services, such as warehousing, storage etc., making them attractive for integration in dedicated logistic concepts (e.g. in the steel or paper industry). Their number is expected to rise strongly, especially in those countries that intend to give up single wagon transport (European Commission, 2016).

Data on rail-ports or other conventional rail-road terminals (RRTs) can be found in 20 (out of 28) EU Member States (please see Map 3 below). As with other intermodal facilities, the majority of these terminals is located in central Europe, in particular in Germany and the Netherlands, but there are also a fair number in Portugal, Belgium, Italy, Poland and Sweden. In total, their number is however small, compared to the other types of last-mile infrastructure, as only 190 rail-ports were identified.

Map 3: Rail-ports and rail-road terminals – occurrence in Europe



Source: HaCon based on CP Carga, DB Schenker, RailScout, SZ

The provision and availability of freight terminals alone is not a sufficient condition to ensure high levels of multimodal connectivity and therefore of the potential for modal shift. The TRACC project[14] highlighted a number of important indicators in this respect, including that, for intermodal transport to be a possibility, freight terminals should be accessible by lorries within 120 minutes.

While most EU regions have access to one or two terminals (mainly in coastal areas), the most accessible areas in Europe have access to more than 100 freight terminals within 120 minutes travel time by lorry (please see Map 4). The latter are concentrated in the Benelux countries, the Rhine-Ruhr and Rhine-Main areas in Germany, but high numbers are also found in northern Italy, Denmark and the Czech-Slovak-Austrian border area. Other important logistic regions include: the Greater Stockholm area, the area between Turku and Helsinki, the Greater Paris area, and northern England (Liverpool, Manchester and

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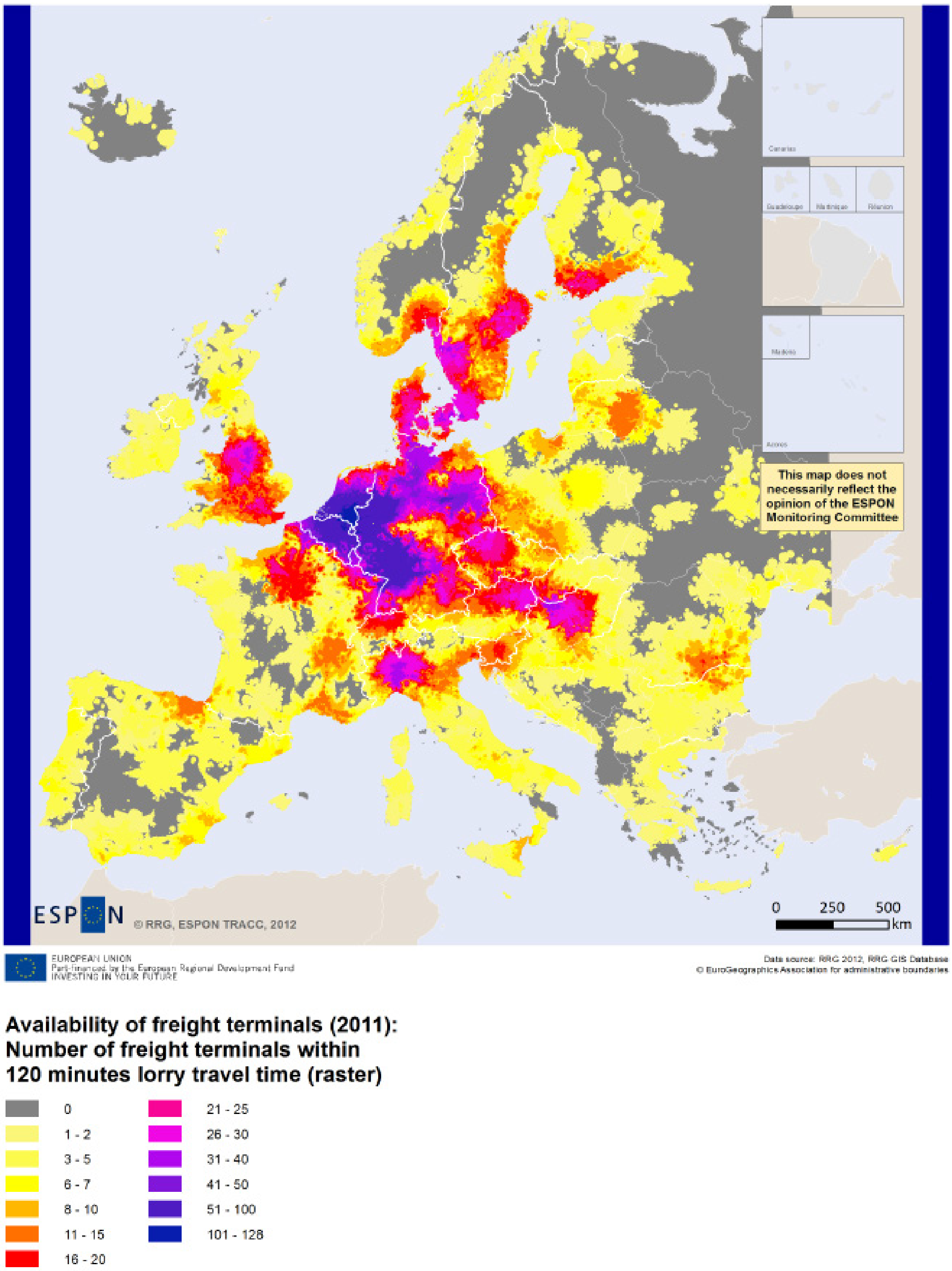
[13] The term 'single wagon' (or wagonload or wagonload freight) refers to trains made of single wagon consignments of freight. The economic downturn has triggered an increase in this type of transport, but it did not help to increase the profitability of single wagon transport (Source: RailwayPro).

[14] The "Transport accessibility at regional/local scale and patterns in Europe" (TRACC) project aimed at implementing and updating the results of previous studies on accessibility at the European scale and at extending the range of accessibility indicators with further indicators corresponding to new policy questions, such as globalisation, energy scarcity and climate change.

Sheffield). At the other extreme, there are large areas that do not have access to any freight terminal. In the EU, such areas are mainly in sparsely populated, landlocked hinterland regions in Scandinavia, France, Portugal and Spain.

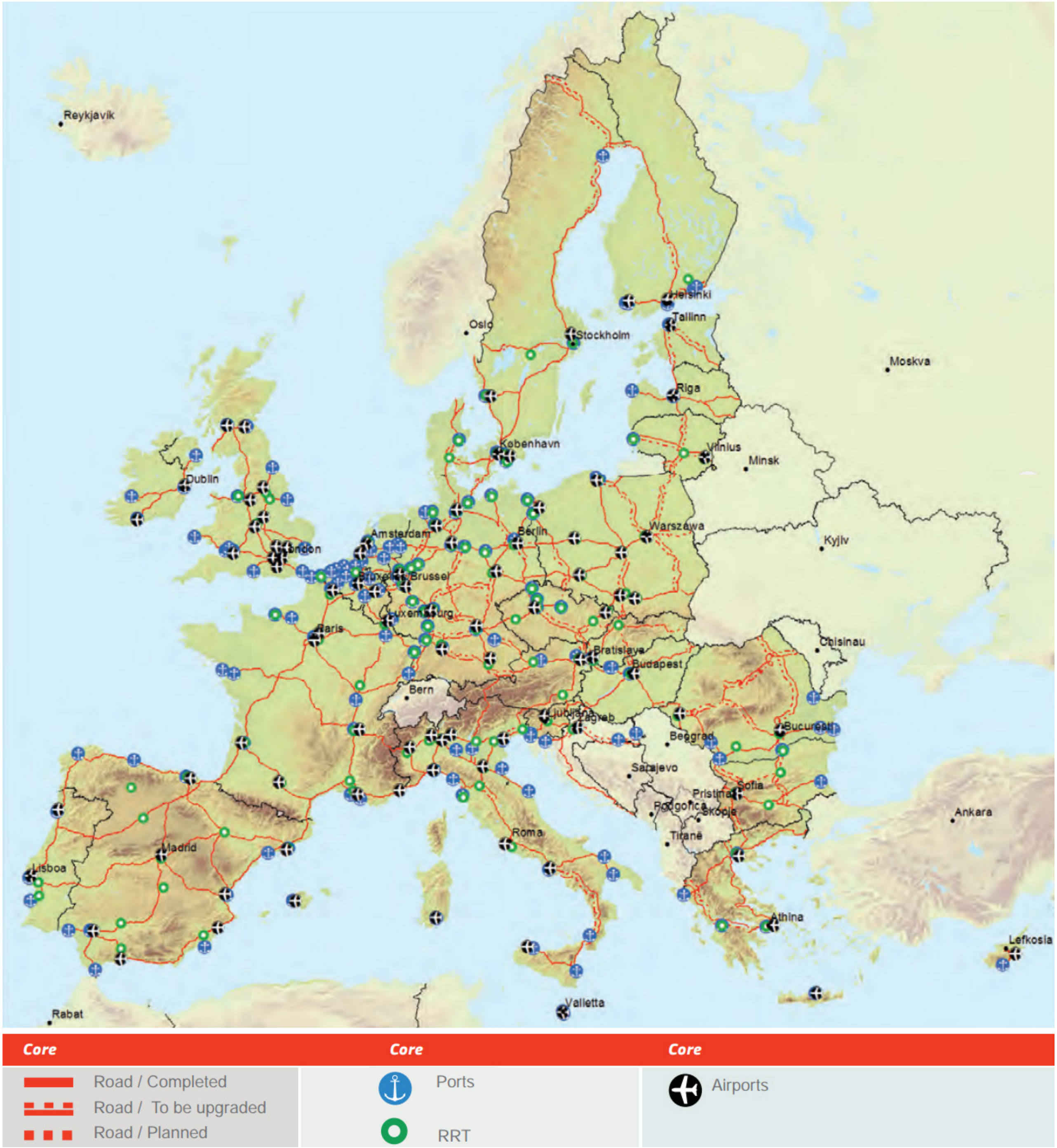
Map 4: Availability of freight terminals (2011): Number of freight terminals within 120 minutes lorry travel time



Source: TRACC project

Similar conclusions on multimodal connectivity can be drawn from Map 5 below, which highlights the location of railways (freight), ports and rail-road terminals (RRTs) on the TEN-T core network in the EU Member States. The map provides an overall insight into multimodal connectivity throughout the EU. Multimodal connectivity is at its highest levels in the Benelux countries and the western Germany macro-area, where the high concentration of sea and inland ports is complemented by an equally dense network of roads, railways, airports (including main hubs) and further multimodal facilities, such as RRTs.

Map 5: Railways (freight), ports and RRTs in the EU Member States (core network)



Source: European Commission's TENtec portal

This information is complemented by the most recent insights provided by the Commission and EU Coordinators for the nine core network corridors in their respective work plans and studies on corridors (European Commission, 2016b-d; European Commission, 2018a-f). From these, it emerges that the EU has different degrees and potential for multimodal connectivity, depending on the Member State.

On the Atlantic side of the EU, there are several issues with connecting sea and rail transport. Although all core ports in the Atlantic corridor are connected to the rail network, in both Portugal and Spain the upgrade of rail connections and rail freight terminals to allow 740 metre-long trains to access the ports (as required by the TEN-T Regulation[15]) is lacking. The electrification of the railway lines connecting the ports of Algeciras and Le Havre, the largest seaports by volume in the corridor, is also missing.

On the Mediterranean side of the EU, the majority of seaports are located in the western part of the Mediterranean Sea, all of them connected to the rail network. However, the density of rail-road terminals is lower in central and southern Italy, compared to the northern part of the country, and connections with seaports could also be improved.

In the eastern part of the EU, the region's multimodal infrastructure is being progressively connected to rest of the Union. The region is also at the crossroads of emerging rail corridors, notably the new "Silk Road" from China, through Ukraine, Russia and Kazakhstan on the eastern side and from Greece to the sea. The density of intermodal terminals and RRTs is still lower than in Member States located in central part of the EU.

The Scandinavian and Baltic regions (the latter one comprising Estonia, Latvia and Lithuania) have low population densities and large areas. As a result, their nodes are concentrated in proximity to the various capital cities and so have more limited connections; these are best developed in southern Sweden and on both sides of the Gulf of Finland. The Copenhagen/Malmo agglomeration is the main gateway and multimodal node of the region, due also to its proximity to the most developed regions.

3.1.2. Level of completion of multimodal core network of TEN-T

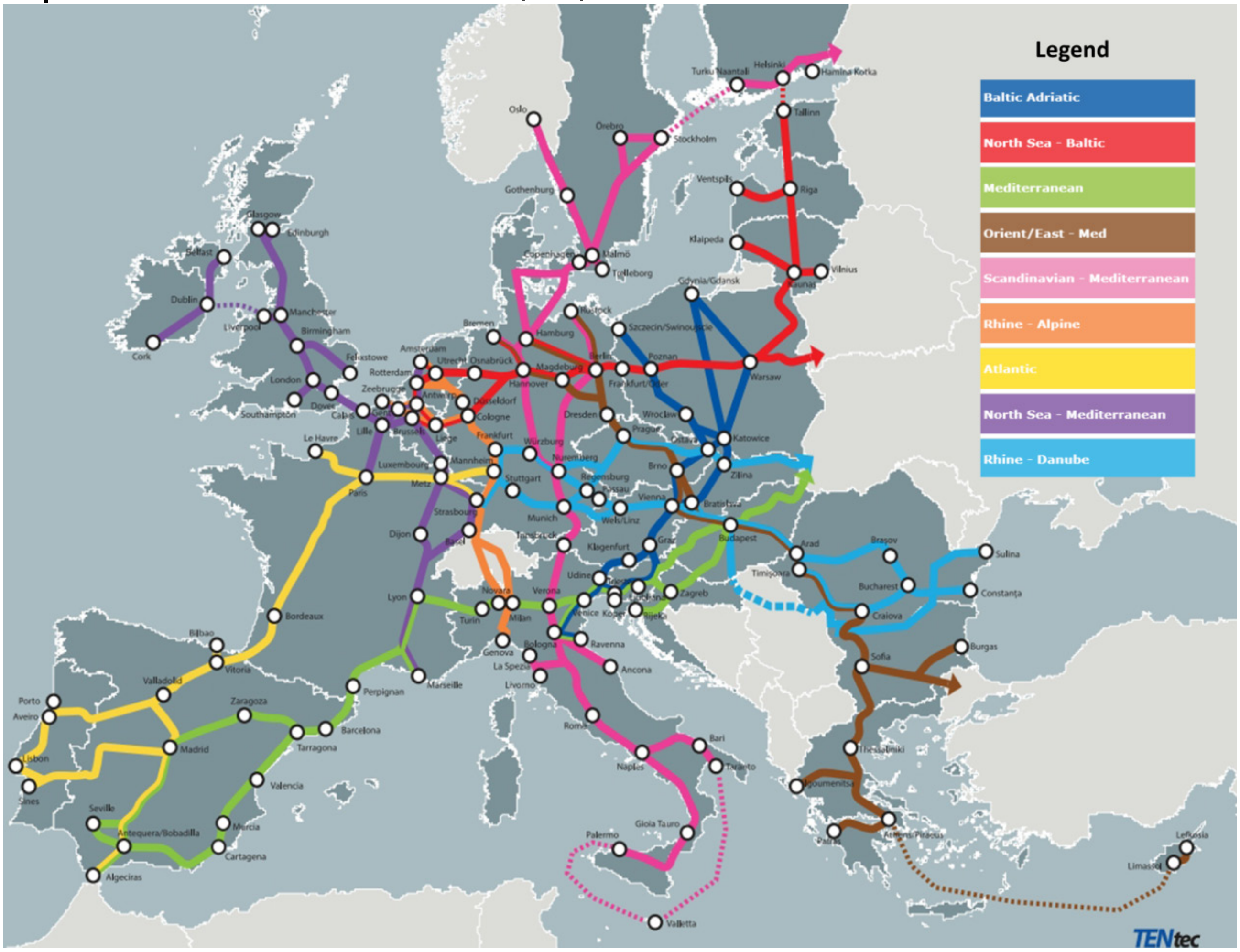
The ultimate objective of TEN-T is to close gaps, remove bottlenecks and eliminate any technical barriers that exist between the transport networks of EU Member States, which should contribute to the strengthening of the social, economic and territorial cohesion of the Union and stimulate the creation of a single European transport area. The EU policy in this area seeks to achieve this aim through:

- the construction of new physical infrastructure;
- the adoption of innovative digital technologies, alternative fuels and universal standards; and
- the modernising and upgrading of existing infrastructures and platforms.

Following the 2013 review of TEN-T policy, nine CNCs were identified to streamline and facilitate the coordinated development of the TEN-T core network (please see Map 6 below).

[15] Regulation (EU) No 1315/2013 of the European Parliament and of the Council of 11 December 2013 on Union guidelines for the development of the trans-European transport network and repealing Decision No 661/2010/EU.

Map 6: TEN-T core network corridors (CNC)



Source: European Commission's TENtec portal

The TEN-T consists of two layers:

- The comprehensive network, which aims to ensure a similar level of accessibility for all EU regions;
- The core network, which is comprised of the most important connections within the comprehensive network.

Table 6 below gives an overview of the progress in completing infrastructure on the core network by mode, according to information provided by the Member States in 2015.

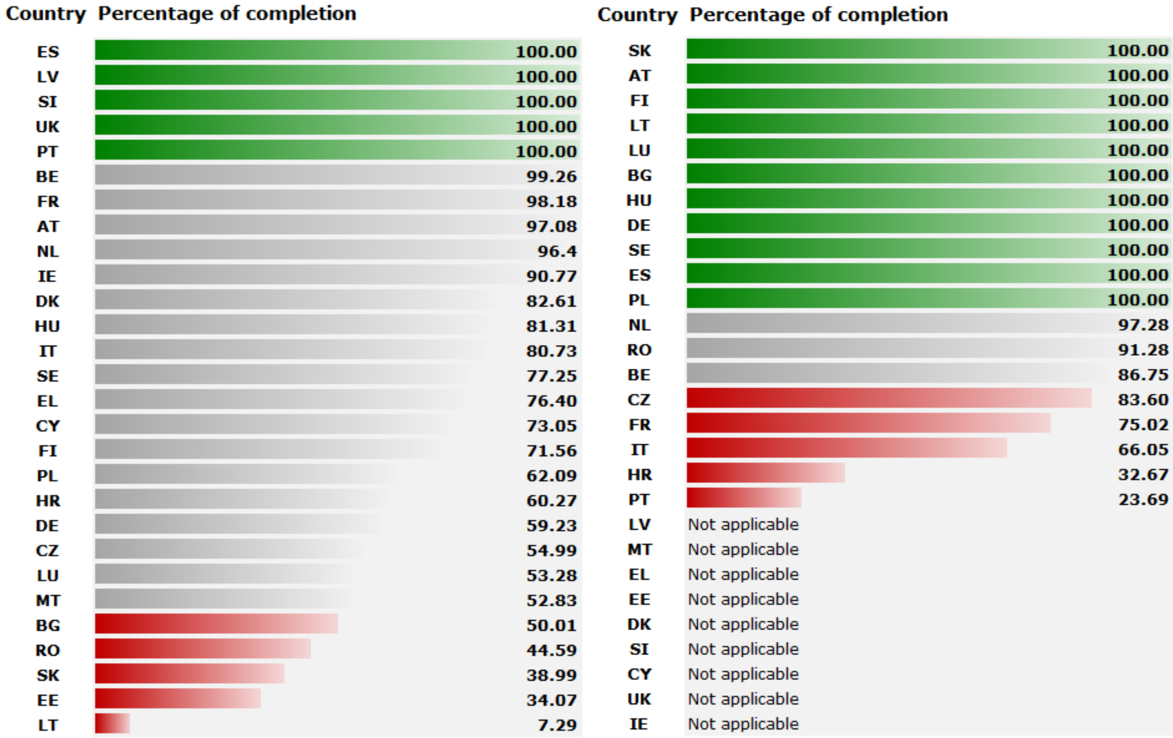
Table 6: Categorised TEN-T core network infrastructure (2015)

Core network	Completed	Under construction/ Ongoing	Planned	Under study/Preparation
Road	**75%**	**4%**	**19%**	**2%**
IWW	**89%**	**1%**	**10%**	**1%**
Conventional Rail	**73%**	**4%**	**22%**	**1%**
High Speed Rail	**61%**	**0%**	**39%**	**0%**

Source: Authors' own elaboration based on TENtec portal

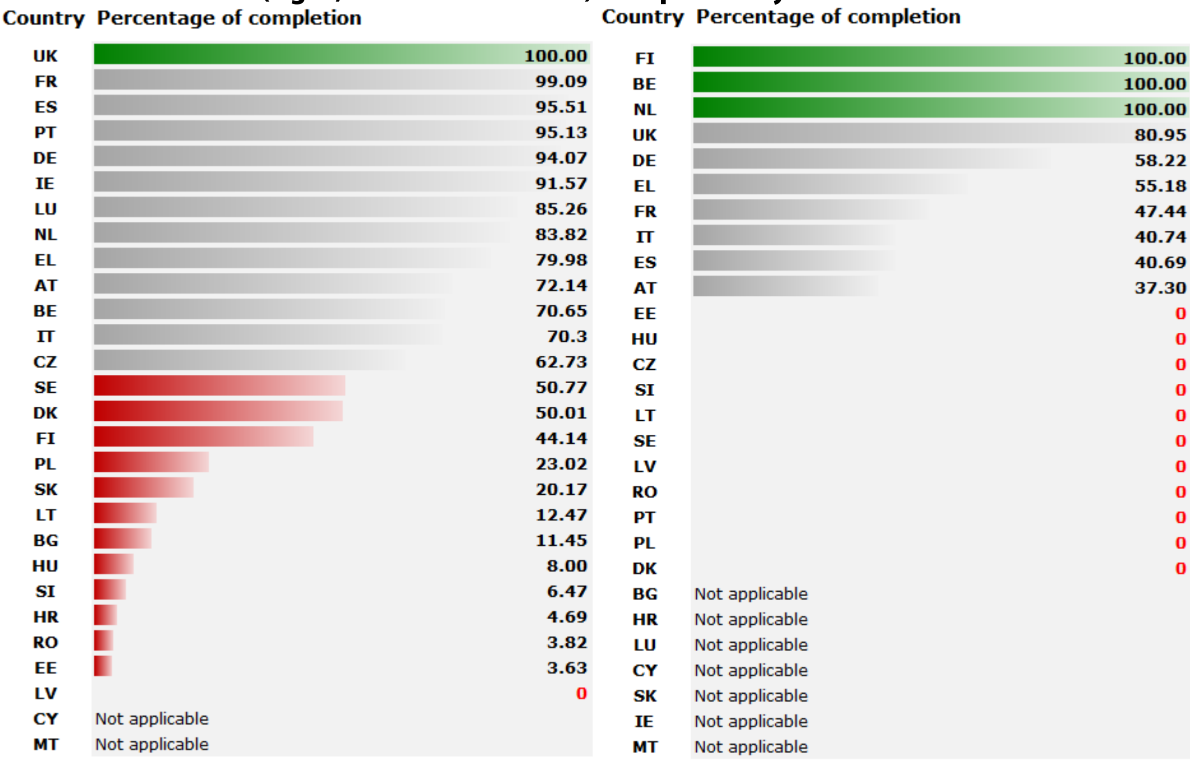
Figure 15 and Figure 16 break down information provided in Table 6 for each EU Member State at the end of 2015, compared to the total, including planned sections and sections to be upgraded. The statistics reflect the official maps contained in Annex I of Regulation (EU) No 1315/2013. The term "completed" refers to "existing" infrastructure on the core network, so – other than for those Member States that have a 100% completion rate – does not mean that the infrastructure requirements, as stated in Regulation (EU) No 1315/2013, have already been implemented. The time horizon for the completion of the TEN-T core network is 2030.

Figure 15: Completion of TEN-T road core network (left) and IWW core network (right) at the end of 2015, as reported by Member States



Source: European Commission's TENtec portal

Figure 16: Completion of TEN-T conventional rail core network (left) and high speed rail core network (right) at the end of 2015, as reported by Member States



Source: European Commission's TENtec portal

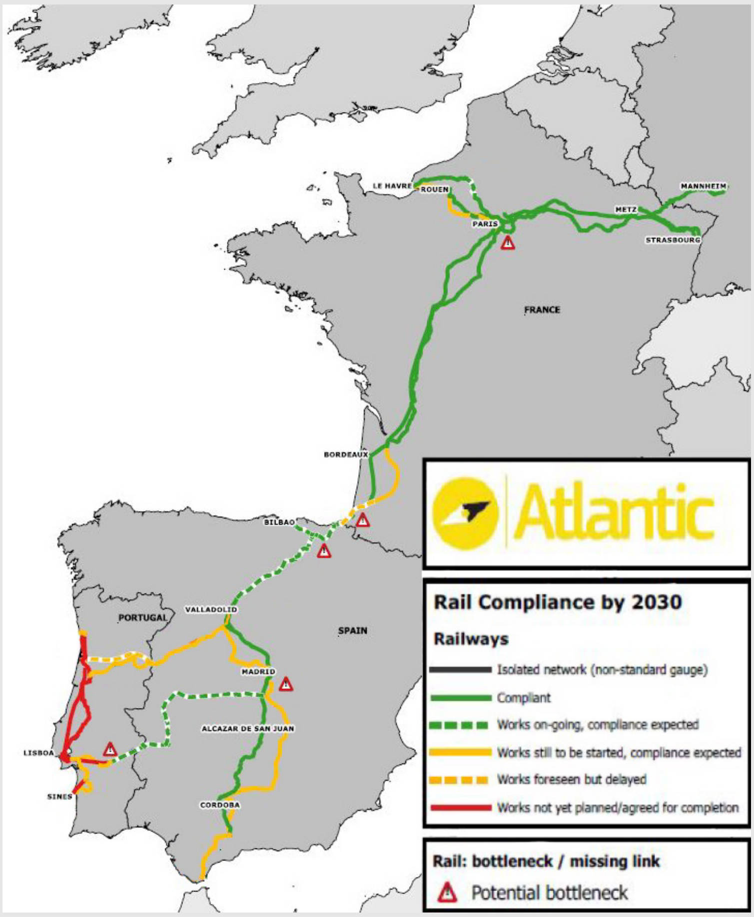
It can be noted that the levels of completion of the core network are low for road and conventional rail, and even lower for the high speed rail network. On the other hand, by 2015 the inland waterways core network was already well developed, 15 years before the target for its completion, with 11 countries already having completed their networks.

Regarding the situation of the nine corridors, Box 1 below represents a summary of the current achievement and challenges ahead for each corridor.

Box 1: Core network corridors: state of play

TEN-T CORE NETWORK CORRIDORS

(1) The Atlantic Corridor (DE, ES, FR, PT)



Source: European Commission Third Work Plan for the Corridor

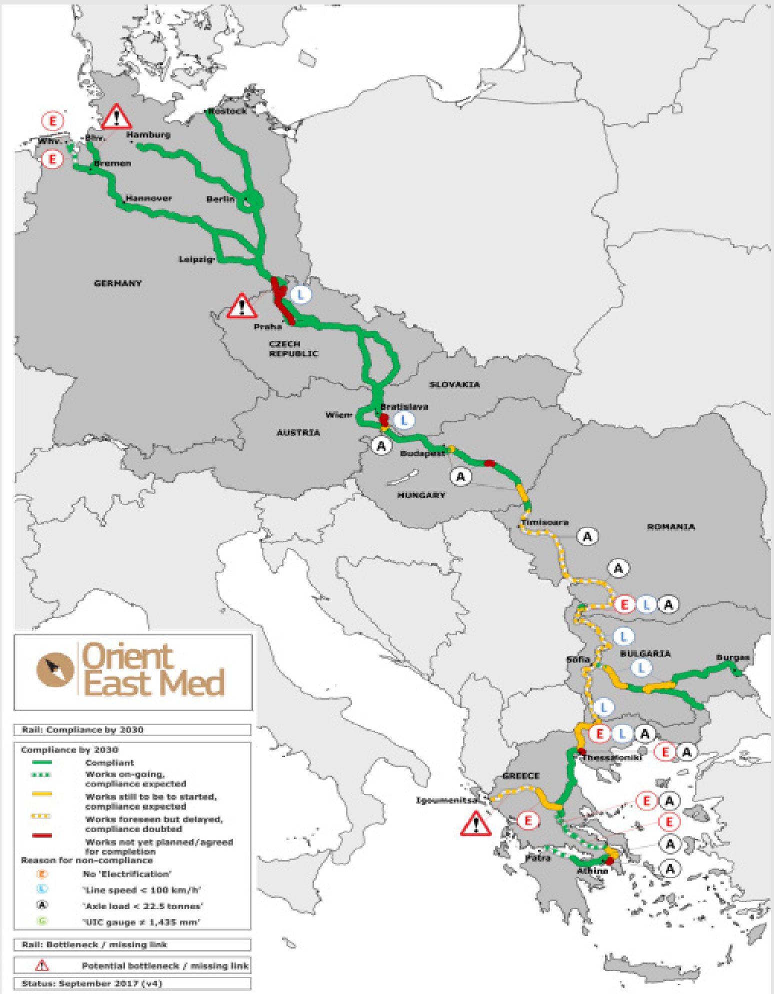
According to the Third Work Plan of the European Coordinator (European Commission, 2018a), the core railway network in the Atlantic Corridor is 7 616 km long, of which 6 105 km (79.9%) are in operation. The Corridor is characterised by the high quality of the existing road network, 99.8% of which fulfils the TEN-T class requirements (motorways or express roads). The Seine River (the only inland waterway in the Atlantic Corridor) already reaches higher standards than the minimum established by the EU regulation.

The Atlantic Corridor already has a high level of compliance with several TEN-T requirements. This is the case especially for its roads, for certain rail parameters, including line speed and axle load, for inland waterways and for the most important parameters of maritime transport, i.e. connection to rail and inland waterways. The remaining gaps are expected to be filled by 2030 and include the electrification of the Corridor's railway lines, train length standards and the availability of clean fuels at inland ports and along roads, as well as the connection of the airport of Madrid-Barajas to the high speed rail network. There are some cases where compliance will not be fully achieved by 2030, including in relation to the track gauge (74% expected in 2030) and ERTMS deployment. Regarding track gauges, the gaps will be only in Portugal in the north of the country.

Bottlenecks in the Corridor mainly relate to intermodal connectivity, for both road and rail, the latter being largely the case in Spain and Portugal as a result of limits on train lengths. For rail, interoperability, notably relating to track gauge, will not be fully achieved by 2030, although critical bottlenecks, notably on the French-Spanish border, will have been significantly reduced. Furthermore, relevant sections of the Portuguese network continue to use the Iberian gauge (i.e. 1 668 mm).

In the next few years, the roads of the Corridor will be fully compliant with the TEN-T requirements. The interoperability of road e-tolling is already quite well advanced. There is a clear potential for the provision of better multimodal services along the Corridor and the improvement of multimodal connections; however, an overall planning, implementation and management model for RRTs, notably in the Iberian Peninsula, is still missing. With regard to road infrastructure, the critical issue relates to the financing of infrastructure for alternative fuels by the public sector. On the other hand, the functioning of the Corridor is hampered by several missing interconnections between sea and rail and the limited integration with the inland logistic chain.

(2) The Orient-East Mediterranean Corridor (AT, BG, CZ, DE, EL, HU, RO, SK)



Source: European Commission's TENtec portal

According to the Third Work Plan of the European Coordinator (European Commission, 2018b), the length of the Corridor's infrastructure is approximately 5 800 km of railway lines, 5 400 km of roads and 1 700 km of IWW. These lengths have changes slightly compared to those presented in the first Work Plan of 2014, as a result of some changes in the definitions used, locally. At the end of 2016, considerable sections of the railway infrastructure in the Corridor were still not compliant with the technical standards set by TEN-T Regulation No. 1315/2013, particularly regarding the key infrastructure parameters, train lengths and the traffic control system (ERTMS).

Overall, around 1 627 km of IWW are compliant with the two TEN-T requirements, representing 98% of the Corridor IWW network. A key requirement of the TEN-T Regulation No. 1315/2013 is a maritime port connection with the road and rail network. The ports of Igoumenitsa and Patra in Greece are currently lacking connections to the country's railway network (giving the Corridor an 80% compliance in this respect). Similar gaps exist in the ports in Bulgaria.

There are 15 core airports along the Corridor. Of the six major core airports, three (Hamburg, Praha and Budapest) still need to be connected to "heavy rail", i.e. rail capable of operating high speed passenger trains. In addition, Bratislava, Timisoara, Sofia and Thessaloniki airports still lack a connection to the rail network. Connection to rail is a key feature for both inland ports and airports. According to the Third Work Plan, connection to rail in inland ports was at 80% and connection to rail for the main core airports was at 50% in 2016.

Numerous missing links on the Corridor will not be addressed before 2030, in particular sections in Bulgaria, the Czech Republic, Romania and Greece. As far as IWW is concerned, the most critical sections are the Czech sections along the German-Czech border and the Elbe River in Germany. Another issue, which is encountered in all corridors, is that there is, as yet, no project in place that provides capacity for alternative fuels for aircraft.

(3) The Baltic-Adriatic Corridor (AT, CZ, IT, PL, SK, SI)

Significant steps forward have been made in the development of infrastructure in the Baltic-Adriatic Corridor for all of the main transport modes: road, maritime, airport and particularly railway transport. According to the Third Work Plan of the European Coordinator (European Commission, 2018c), activities for the development and implementation of more than 400 projects have already started. Out of these projects 87 projects have been already completed.

The Corridor includes 4 285 km of the UIC standard gauge (1 435 mm) railway infrastructure. The Corridor's railway infrastructure is already continuous and in operation with only the exception being two sections in Austria. The 3 600 km length of road infrastructure in the Corridor is also not entirely compliant with the requirements of the TEN-T Regulation (EU) No 1315/2013, especially with regards to meeting the standards for expressways and motorways. This is particularly the case for the Polish road network. Currently, 16% of the road infrastructure here constitutes ordinary roads that do not comply with the TEN-T requirements.

There are ten core ports in operation in the Corridor, of which five are classified as maritime and inland waterway ports, three as maritime ports and two inland waterway ports. All are connected to the road and railway infrastructure of the Corridor. However, issues with last mile railway and/or road interconnections to ports still exist and limit the development of the Corridor's seaports.

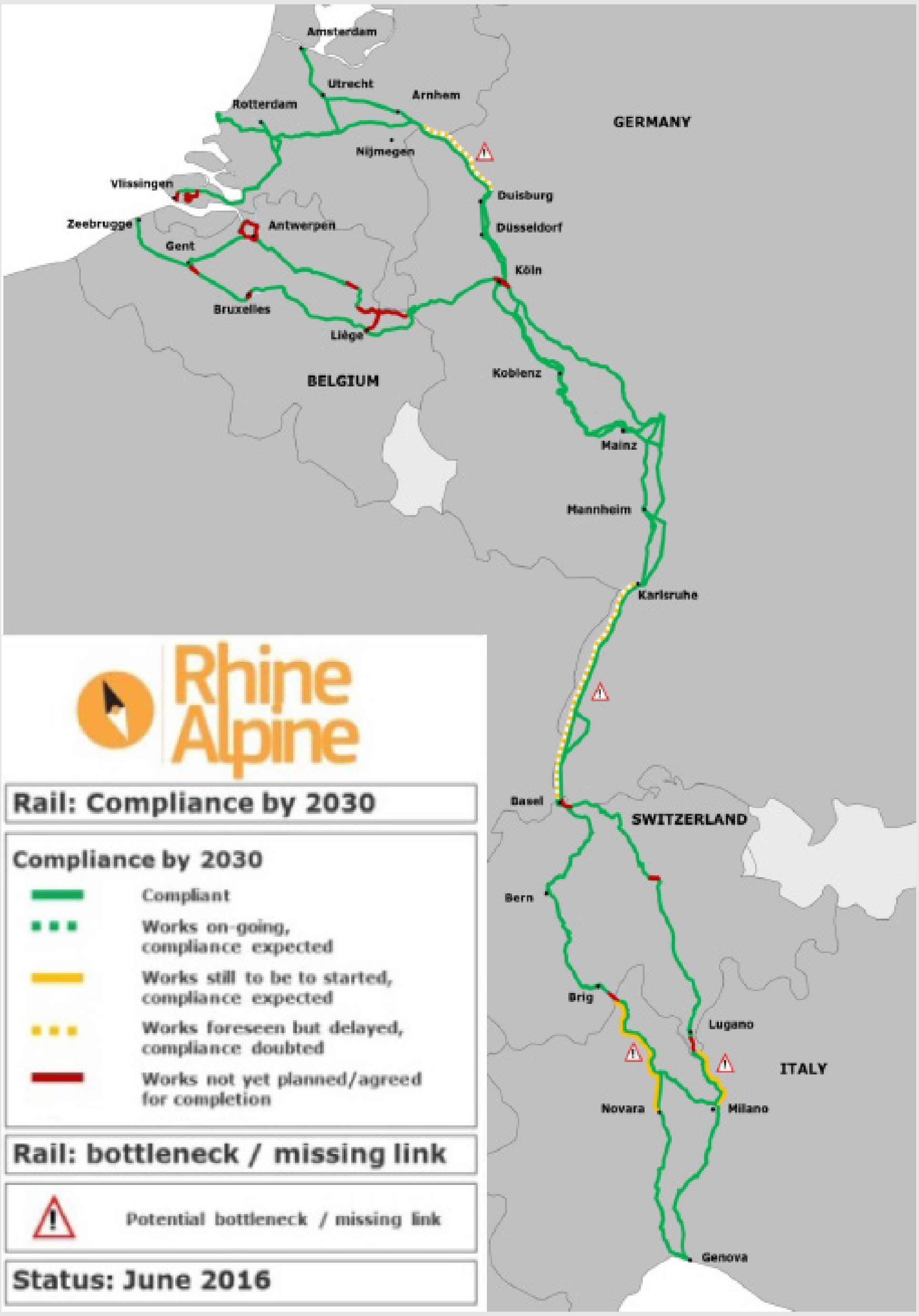
There are 13 core airports in the Corridor all of which are connected to the road network, although only two core airports (one in Austria, the other in Poland) are connected to the Corridor's railway network. 24 RRTs are currently in operation in the vicinity of the Corridor's core nodes, as defined by Regulation (EU) 1315/2013, and they are all connected to their respective national road and rail networks. Few specific issues have been identified that would affect the quality of last mile connections, except for some capacity constraints in Poland and Slovakia.

Source: European Commission's TENtec portal

There are still outstanding bottlenecks along the Corridor on six railways and two road cross-border sections, in terms of their compliance with the TEN-T requirements (i.e. on the following borders: Poland-Czech Republic, Poland-Slovakia, Czech Republic-Austria, Austria-Slovakia, Austria-Slovenia and Italy-Slovenia). There are still some issues on critical cross-border road sections between Poland and Slovakia, and between the Czech Republic and Austria.

As far as the last mile connections of the ports are concerned, there are critical issues in the Polish ports of Gdynia, Gdańsk, Świnoujście and Szczecin in the north, the Vienna and Bratislava inland waterways ports, and the Italian ports of Trieste, Venice, Ravenna and the port of Koper in Slovenia in the south.

(4) The Rhine-Alpine Corridor (BE, DE, FR, IT, NL)



Source: European Commission's TENtec portal

The Corridor's extensive road network fulfils, to a great extent, the TEN-T requirements. The IWW network in the Corridor is fully compliant with the minimum standard requirements[16] . Nevertheless, some of the Rhine sections are not navigable during extremely dry conditions. As far as maritime transport is concerned, the port infrastructure of the Corridor complies with almost all of the criteria set in the TEN-T Regulation (EU) 1315/2013.

According to the Second Work Plan of the European Coordinator (European Commission, 2016c), there is a need for upgrades in the railway cross-border sections in the Netherlands, Germany, Switzerland and

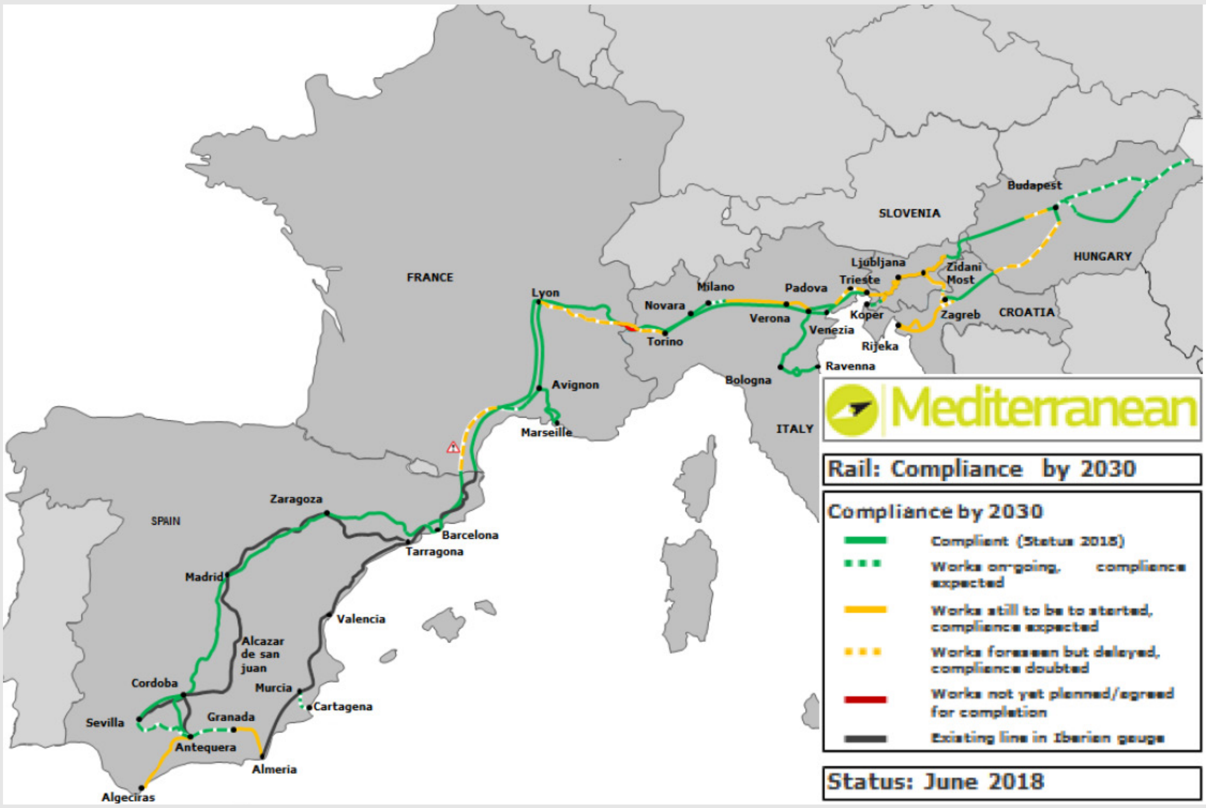
[16] The CEMT classification is the system for classification of the European inland waterways adopted by the European Conference of Ministers of Transport (French: *Conférence européenne des ministres des Transports*, *CEMT)* in June 1992. This classification specifies the minimum standards for the European inland waterways and ranges between I and VII. Here, the minimum standard refers to Class IV.

Italy. The main challenges for the Corridor are bottlenecks resulting from increased traffic flows. Capacity bottlenecks on the Corridor's road infrastructure are also common, as there are serious traffic congestion problems along many motorway sections on the Corridor.

Limitations in multimodal transhipment capacity are also an important issue, particularly in Belgium, France, Germany and Italy. In France, there are various cross-border, interoperability and multimodality issues in Strasbourg, including a need for a better connection and electrification of the rail lines to the inland port and improvements to the stocking capacity for empty containers.

Regarding airports and seaports, the main compliance issues in the Corridor are the missing connections to the rail network. As far as airports are concerned, improvements are needed for the freight hubs and smaller airports along the Corridor, where rail connections are needed to support the integration of multimodal transport chains.

(5) The Mediterranean Corridor (ES, HR, FR, HU, IT, SI)

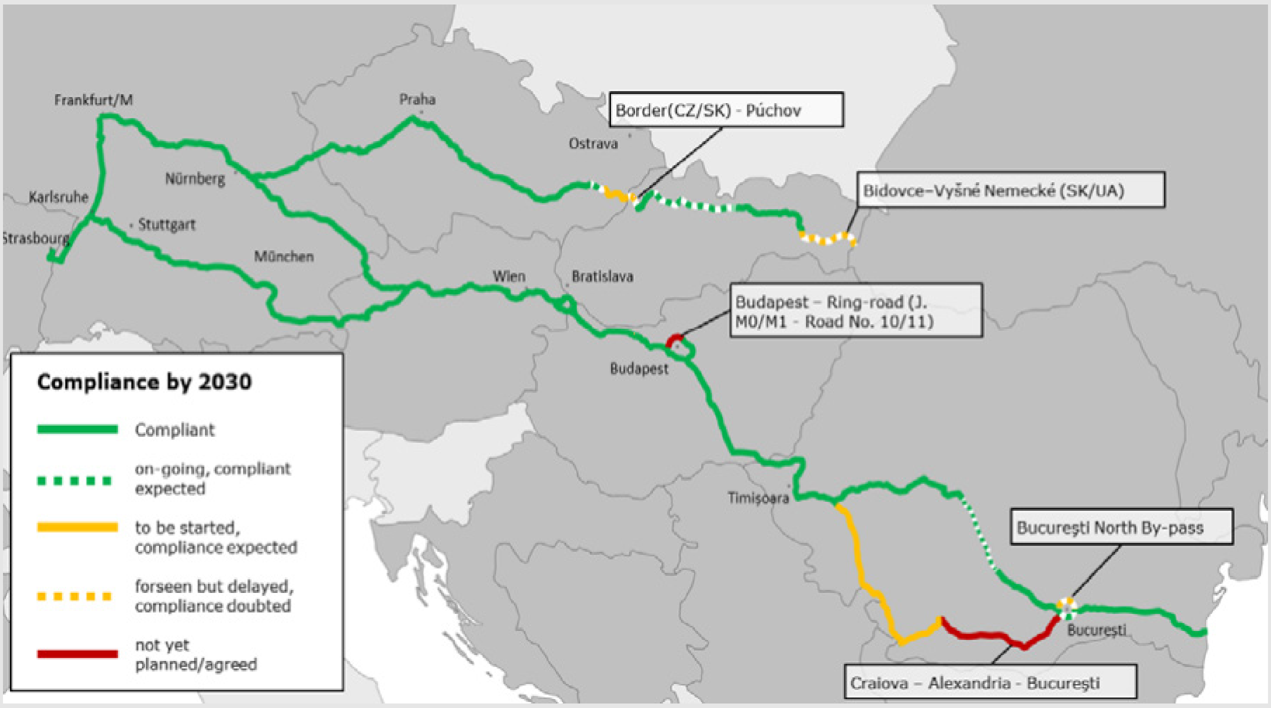


Source: European Commission's TENtec portal

The Mediterranean Corridor is one of the most interconnected in the EU, since it is crossed by other six CNCs. The Third Work Plan of the European Coordinator (European Commission, 2018d) shows that all of the Mediterranean ports already meet the basic requirements of TEN-T Regulation (EU) 1315/2013, i.e. that all core water-based ports need to be connected with rail. With regards to express roads/motorways, only 2% of the sections (i.e. the Hungarian section close to the Ukrainian border) are not yet compliant with the TEN-T standards.

Cross-border sections are where most issues are found, e.g. with the persistence of bottlenecks many of which are located between Slovenia, Croatia and Hungary. Multimodal connections with ports in Spain and France have to be developed and some railway sections in Italy and France need to be upgraded in order to remove key bottlenecks. The coexistence of two gauges (1 668 mm in Spain and 1 435 mm in the other countries) is another challenge for this Corridor, as is the need for the full integration of the newest Member State, Croatia. Another urgent issue is the need for the effective integration of urban nodes in the Corridor.

(6) The Rhine-Danube Corridor (AT, CZ, DE, FR, HU, RO, SK)



Source: European Commission's TENtec portal

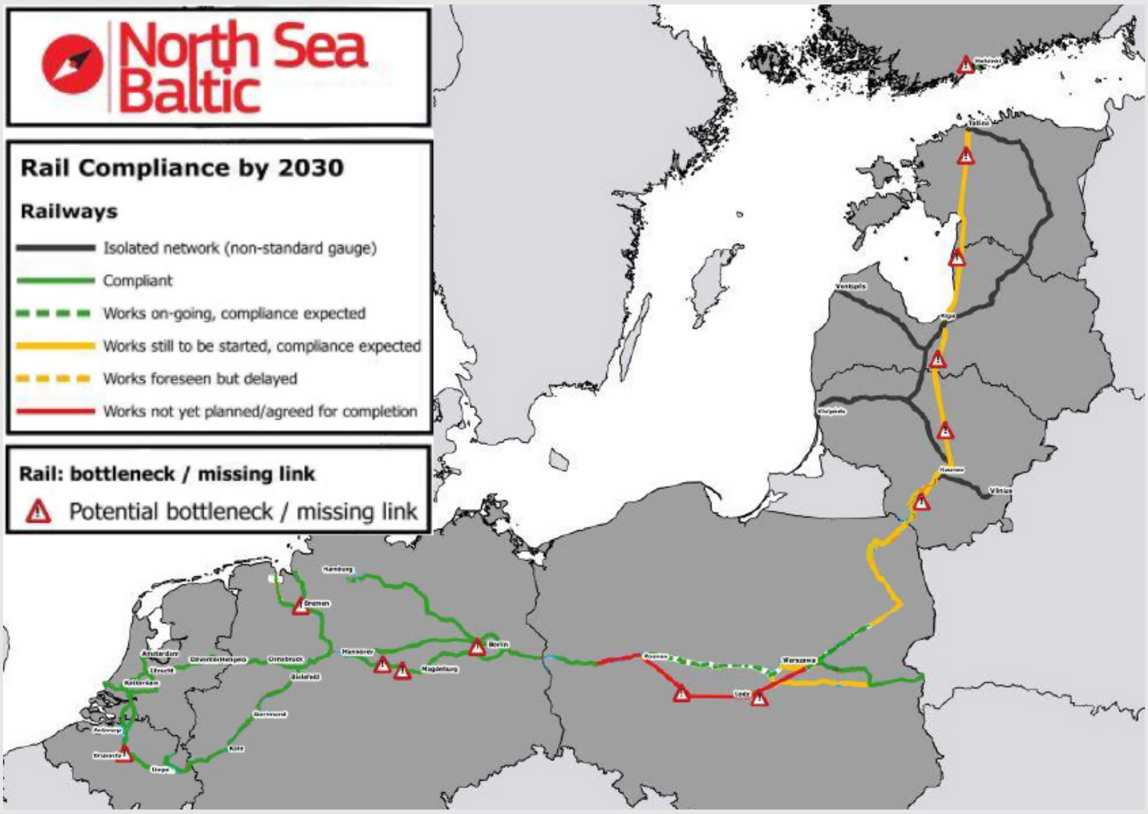
In total, there are 5 715 km of railways, 4 870 km of roads and 3 656 km of inland waterways on the Corridor. The 19 inland ports outnumber the two seaports, while there are also 11 airports, as well as 14 intermodal freight terminals and 27 terminals dedicated to rail and road only.

In the Corridor, substantial progress can be expected with respect to rail by 2030. However, there are several risks, especially with the cross-border connections. The main missing links are cross-border rail connections between Germany and France, and between Austria and the Czech Republic. Bottlenecks in Slovakia, Hungary, Romania and Bulgaria, and between Austria and Slovakia, also need to be addressed.

The navigation of the Rhine River and its connection with the Rhine-Main-Danube Canal are of a high standard, although improvements need to be made to the Danube River if these inland waterways are to offer a genuine alternative modal choice as an integrated Corridor for freight transport. In addition, the western Balkans section of the Danube plays an important role in the functioning of this Corridor and must, therefore, attain similar high standards. A high proportion – 87.5% – of inland and sea ports are the subject of infrastructure works and studies, although it is anticipated that gaps in the development of the ports in the Corridor will remain in 2030 (European Commission 2016c).

As far as roads are concerned, on 91% of the works are either ongoing or planned, but there are still some sections in Slovakia and Romania that are expected to remain incomplete in 2030. Furthermore, there are still some missing sections of the core road network in the Czech Republic, Slovakia and Romania. Several multimodal terminals will fulfil the requirements of TEN-T Regulation (EU) No 1315/2013 to a higher degree in 2030 than they did in 2016 but are still expected to lack compliance with all the TEN-T parameters.

(7) The North Sea-Baltic Corridor (BE, DE, EE, FI, LT, LV, NL, PL)



Source: European Commission's TENtec portal

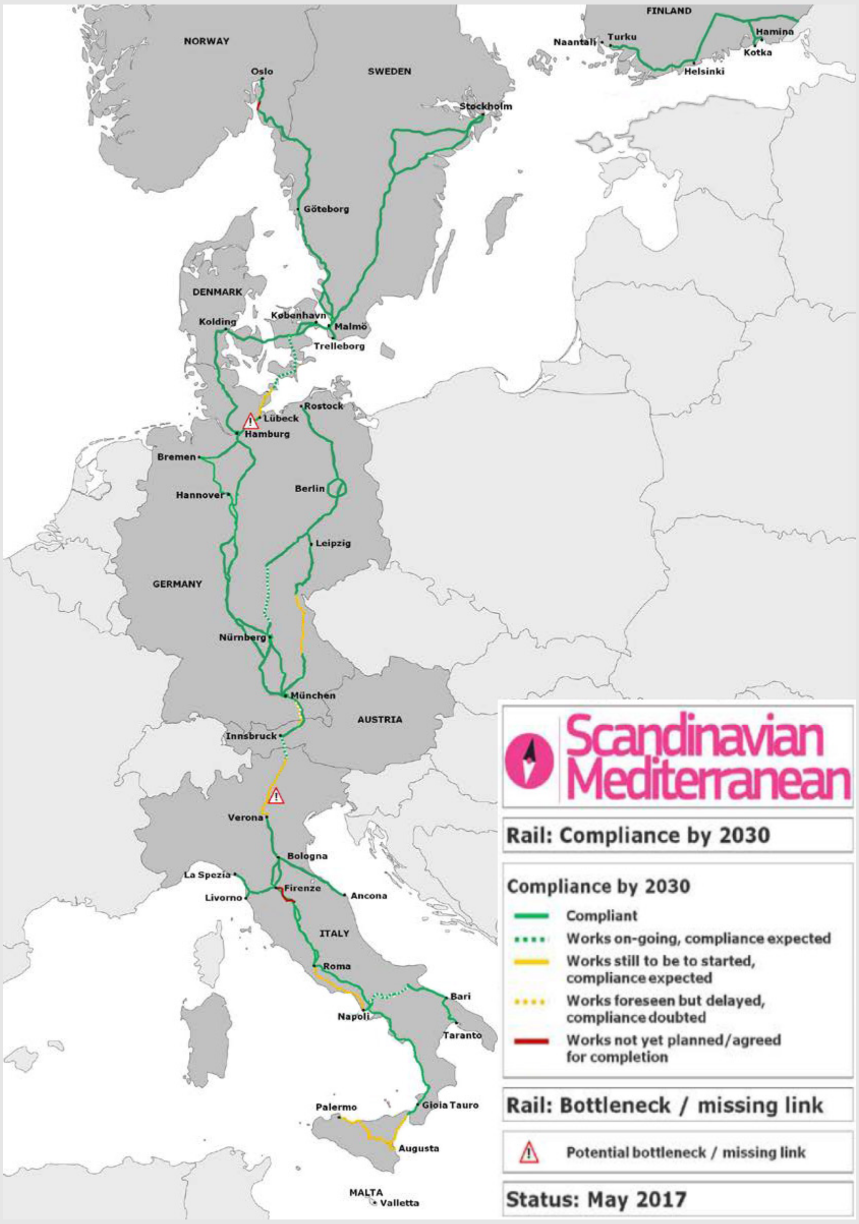
The North Sea-Baltic Corridor comprises 5 986 km of railways, 4 092 km of roads and 2 186 km of inland waterways. The Corridor has seen significant improvements in the road and rail networks, including in proximity to the seaports. In fact, all core seaports on the Corridor are connected to the rail and road network, although in some cases the capacity of these connections is not sufficient.

In addition, there are also capacity issues for rail, according to the Third Work Plan of the European Coordinator (European Commission, 2018e), both for some short sections near busy nodes and in some long stretches of the network, particularly in Belgium, the Netherlands and Germany.

Capacity problems in inland waterways occur mainly at locks, where the most important issues are encountered in the Dutch IWW network. The most critical cross-border issue in the Corridor is the missing 1 435 mm UIC standard gauge railway line from Tallinn through the Baltic States to the Polish border that still needs to be addressed to ensure the implementation of the Rail Baltica project.

As for the road network of the Corridor, capacity issues were identified in all countries. The problems are especially noticeable in and around urban nodes, where city bypasses and ring roads are often very congested.

(8) The Scandinavian-Mediterranean Corridor (AT, DE, DK, FI, IT, MT, SE)



Source: European Commission's TENtec portal

The Scandinavian - Mediterranean (Scan-Med) Corridor is the longest of the CNCs with more than 9 300 km of railways and in excess of 6 300 km of roads. The Corridor also includes 25 core water ports, 19 core airports, 45 core intermodal terminals and 19 core urban nodes. The Corridor crosses almost the whole continent from the north to the south.

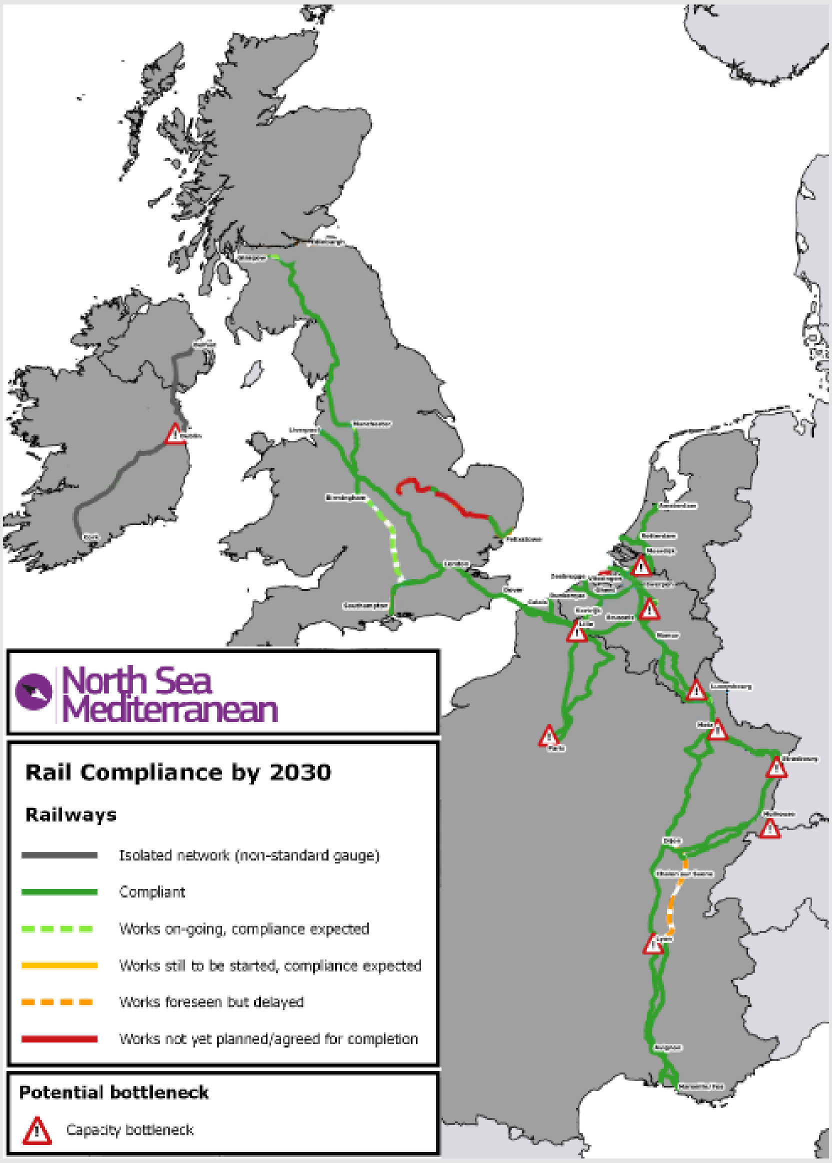
The overall compliance of the rail network will not be achieved by 2030. Persistent bottlenecks have been identified in the Third Work Plan of the European Coordinator (European Commission, 2018f) for each country. There are also some technical parameters that have not been yet achieved in the German and Italian sections of the Corridor.

At present, it seems that the sea ports will only be 100% compliant with four of the eight maritime parameters by 2030, although almost all of the seaports (92%) are implementing or planning projects to modernise and expand their capacity. However, it is important to note that port environmental infrastructure is still being developed.

With regard to road transport, by 2030 almost 100% of the road sections, with the exception of a short connection in western Finland and another in Italy, will be compliant with the TEN-T requirements for express roads or motorways. Capacity bottlenecks on roads are currently present in Finland, Sweden, Germany, Denmark and Italy.

Furthermore, 16 out of the 19 airports of the Corridor will offer multimodal connectivity by 2030, while open access is already available in all 19 core airports. All of the airports are connected to the TEN-T road network, while 12 airports are also connected to the rail network. With regard to seaports, there are differences between the connectivity of the northern ports and the rest of the ports of the Corridor. The critical issues for RRTs generally relate to rail and road access, as well as handling and intermediate storage capacity.

(9) The North-Sea Mediterranean Corridor (BE, FR, IE, LU, UK)



Source: European Commission's TENtec portal

The North Sea-Mediterranean Corridor stretches from the Scottish capital Edinburgh in the north, to the French ports of Marseille and Fos-sur-Mer in the south. When complete, the Corridor will offer enhanced multimodal links between the North Sea ports, major European rivers basins and the southern French ports of Fos-sur-Mer and Marseille.

Given the high volumes of traffic in the Corridor and its great reliance on road transport, as well as the need to increase the sustainability of freight transport and passenger mobility, there is a clear need to focus on developing infrastructure for inland navigation and rail. There is also still a significant amount of work to be done to achieve fully interoperable technical standards for the rail network and to address all of the issues identified in the Corridor. In the United Kingdom and Ireland, rail connections present the most significant challenge (European Commission, 2016d).

Moreover, on the "continental side" of the Corridor, inland waterways represent the biggest challenge, with missing links and bottlenecks identified between the Seine and the Scheldt, and between the Rhine and the Rhône. There is also a continued need to improve the multimodal connections between airports in the Corridor and their catchment areas.

3.1.3. Level of implementation of rail freight corridors

Aligned with the CNCs, rail freight corridors (RFCs) are defined by Regulation (EU) No 913/2010[17], together with measures to ensure their interoperability and commercial development. RFCs are part of EU strategic policy to create a European rail network for competitive freight by means of cooperation between the rail infrastructure managers within the framework of each corridor. Each RFC has a dedicated governance structure to make the corridor functional, which is more complex than that of the CNCs.

RFCs are set within – and integrated with – the TEN-T core network corridors and the European Railway Traffic Management System (ERTMS) framework. The routing of RFCs may differ from TEN-T core network corridors, as RFCs follow routes more appropriate for freight traffic, for instance avoiding urban nodes.

Regulation (EU) 913/2010 contains the provisions for the creation of a European rail network for the competitive transport of goods. To this end, the Regulation has established the procedures for the national rail network managers of the countries through which the RFCs pass in order to ensure the corridors' effective implementation. Among the main measures contained in the Regulation are:

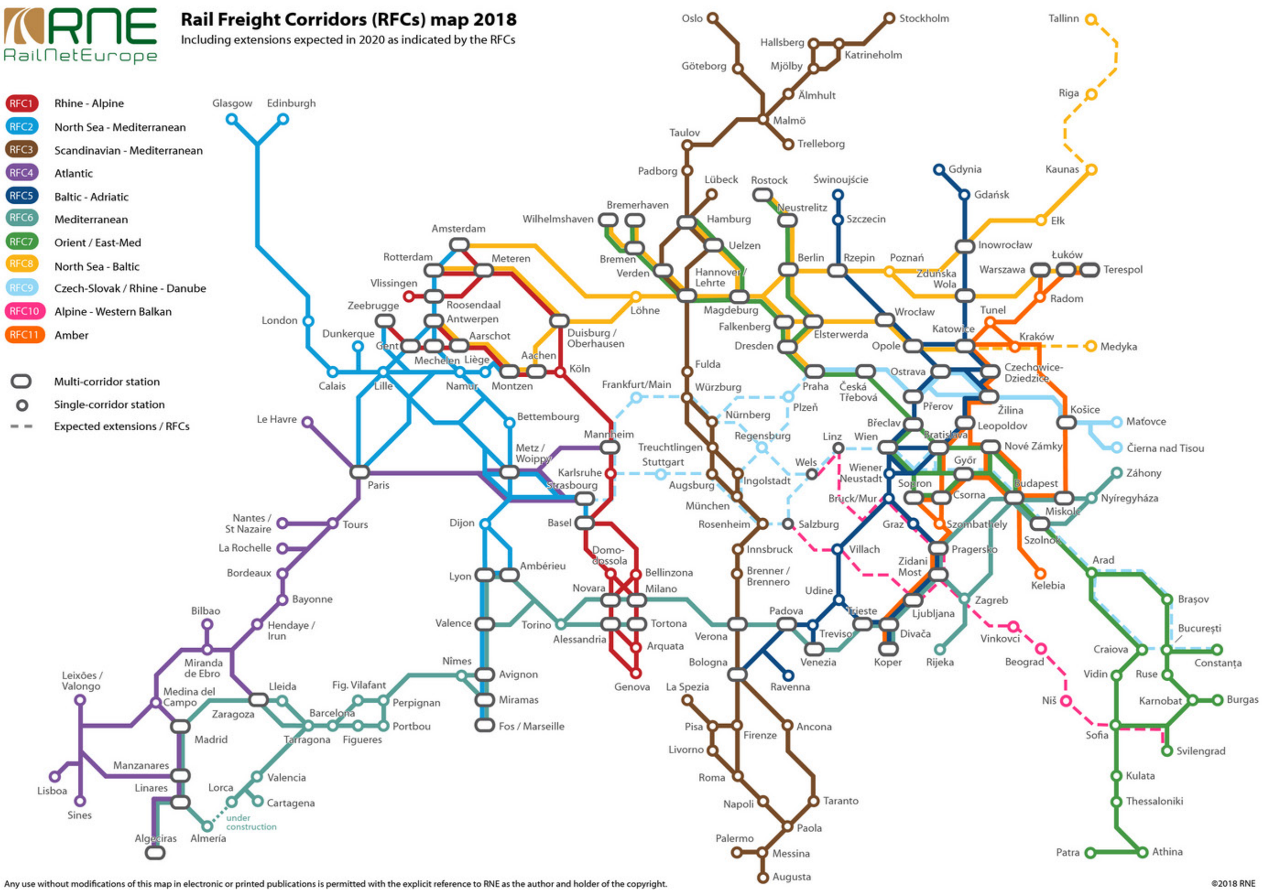
- the implementation of the RFC interoperability subsystems in order to allow trains to pass from one national network to another without encountering technical barriers;
- the coordination of investments to bring all lines in each RFC in line with the standards of the Technical Specifications for Interoperability (TSIs);
- the publication and updating of Corridor Implementation Plans describing the characteristics of the reference transport market, bottlenecks, investments and traffic management procedures suitable for improving the performance of competitive freight rail transport;
- the creation of a single corridor entity responsible for the publication and allocation of capacity for international freight transport, called the One Stop Shop, a single point of contact for each corridor;
- the creation of pre- arranged paths (PaPs) in the RFC to promote international rail freight transport;
- the analysis of freight train performance and customer satisfaction by means of international freight train monitoring systems.

There are 11 RFCs, six of which were set up by November 2013, other three were set up in November 2015, while two additional rail freight corridors have been set up very recently in Eastern Europe. The Commission decided, in March 2018, to set up the Alpine-Western Balkans RFC which should begin operations in two years (Prorail, 2018a). This follows the implementation of the so-called "Amber" RFC 10

[17] Regulation (EU) No 913/2010 of the European Parliament and of the Council of 22 September 2010 concerning a European rail network for competitive freight.

established in 2017, connecting Poland to Slovenia (Prorail, 2017). An overview of RFCs as of 2018 is reported on Map 7 below.

Map 7: Map of the rail freight corridors, updated for 2018



Source: RailNetEurope (2018)

The governance structure of each RFC comprises an Executive Board (including representatives of the Member States concerned), and a Management Board (composed of relevant Infrastructure Managers and capacity allocation bodies). The Management Board comprises two advisory groups, one dedicated to terminals and the other to railways, ensuring the involvement of corridor users, as well as representatives of terminals and ports along the corridors. Amongst its tasks, the Management Board is responsible for drawing up the implementation plan for the corridor, including:

- a description of the infrastructure, its bottlenecks and the measures foreseen to improve rail freight;
- an investment plan comprising an implementation schedule, all of which are supported by the result of a corridor transport market study.

Economic investments are normally targeted at addressing infrastructure bottlenecks and at raising the standards on the rail network, particularly to accommodate the transit of 740 m long freight trains on electrified lines equipped with ERTMS, allowing speeds of up to 100 km/h and axle loads up to 22.5 tonne (Troche, 2015).

The Management Boards of each RFC monitor the performance of rail freight services on the respective freight corridor and publish an implementation report every year. Specific key performance indicators have been set to facilitate monitoring and to enable comparisons to be made over time and between corridors.

The Annual Reports for 2017 provide the most up-to-date figures and information about the performance of each RFC.

The overall performance of the RFCs is reported using capacity and operational performance (punctuality) indicators. Generally, all the RFCs have seen their volumes of freight transported increase (e.g. 38% growth on the North Sea – Mediterranean since its implementation).

Punctuality rates vary between individual RFCs, with the Atlantic Corridor achieving the highest scores (70% at origin and 58% at destination), while the Baltic-Adriatic Corridor is the worst in terms of punctuality. Initiatives are being taken by some RFCs to increase the punctuality rate to up to 70-80% in order to meet the demand of the market.

The management and allocation of PaPs is another important aspect that is defined by the corridor organisations and the Infrastructure Managers PaPs are train paths offered in an annual catalogue, which are pre-defined and harmonised at network borders. Thanks to the pre-allocation process, each RFC is able to optimise the use of its capacity.

Despite the Commission having noted that in some fields progress has been made, even for the harmonisation between the different RFCs, the European Court of Auditors (ECA) in 2016 has found that "the performance of rail freight transport in the EU remains unsatisfactory [...] in terms of (both) volume transported and modal share" (ECA, 2016).

3.1.4. Level of implementation of high speed railways

High speed railway lines (HSR) are designed for trains travelling at a speed higher than 200 km/h on upgraded conventional lines, and at more than 250 km/h on new dedicated lines (European Commission, 2010a)[18]. On the most recent lines, high speed trains can reach 360 km/h, while trains running on upgraded conventional lines can reach speeds of up to 250 km/h[19].

Historically, Japan became the first country operating high speed railway lines in 1964, when the 515 km *Shinkansen* (i.e. "bullet train") line from Tokyo to Shin Osaka was opened to traffic. A decade later, in response to 1974 petrol crisis, some European countries decided to develop an alternative to road transport. Italy was the first to operate a high speed railway line in 1977 (i.e. the "Direttissima", a 254 km section from Florence to Rome). France followed by launching high speed railway services on the line between Paris and Lyon in 1981. Germany introduced the Intercity Express train (i.e. "ICE") in 1991, followed by Spain's "AVE" early in the 90s. Later, the group of forerunners was joined by Belgium in 1997, the UK in 2003 and the Netherlands in 2009.

The 2011 White Paper on transport envisaged that the EU's high speed railway network should triple in length by 2030 and be completed by 2050. To advance towards the goals set, in 2013 the EU introduced the Connecting Europe Facility (CEF), an instrument introduced to support the implementation of the TEN-T (particularly, the projects on core network and with priority for the railway in general, HSR included) (European Commission, 2013b).

As regards the development plans at national level, the Czech Republic, the three Baltic States, Poland, Portugal and Sweden have planned to implement a total of 3 483 km of totally new high speed railway lines. France and Spain have the largest stand-alone development plans, i.e. 1 713 and 1 061 km,

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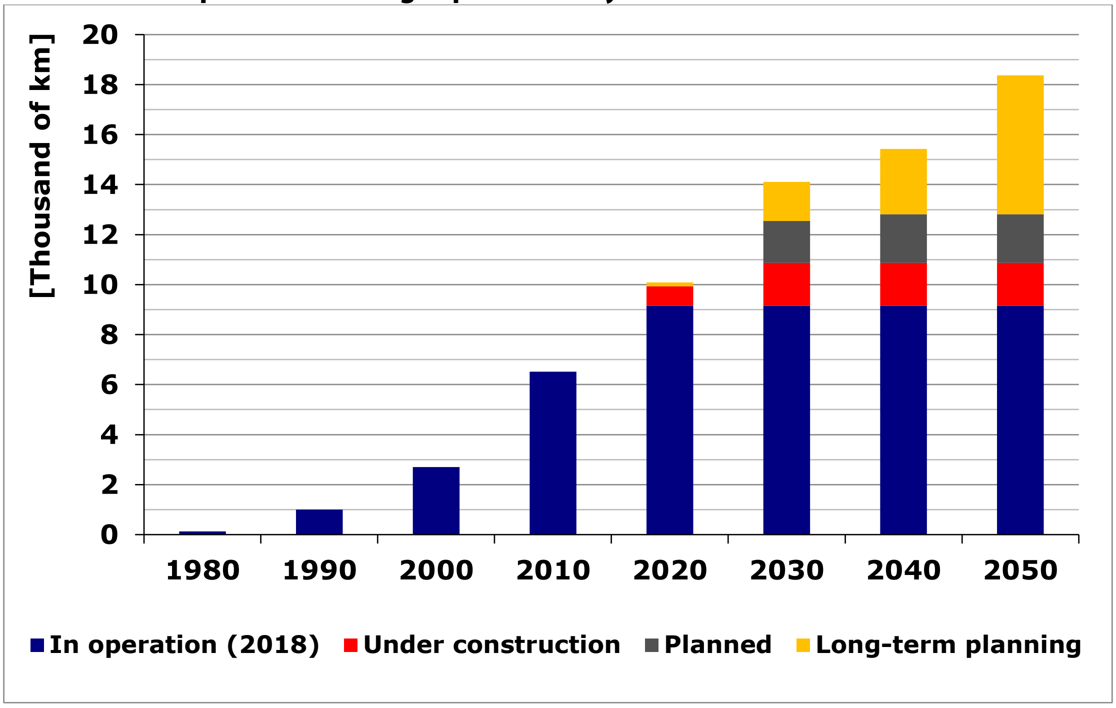
18 There is no single definition of what comprises high speed railway infrastructure. The most commonly used can be found in Annex I of Council Directive 96/48/EC of 23 July 1996 on the interoperability of the trans-European high speed rail system (European Commission, 1996b).

19 Even if a high speed railway line is defined as being "dedicated", a distinction should be made between "fully" dedicated systems (e.g. in Japan) and "integrated" systems. The latter may take a number of forms. For example, high speed services using conventional tracks (e.g. in France), conventional passenger services using high speed tracks (e.g. in Spain) or even a mixture of conventional and high speed services (including freight) on high speed railways (e.g. in Germany).

respectively. Italy and Germany also plan to implement more high speed railway lines, but on a much smaller scale (152 km and 210 km, respectively).

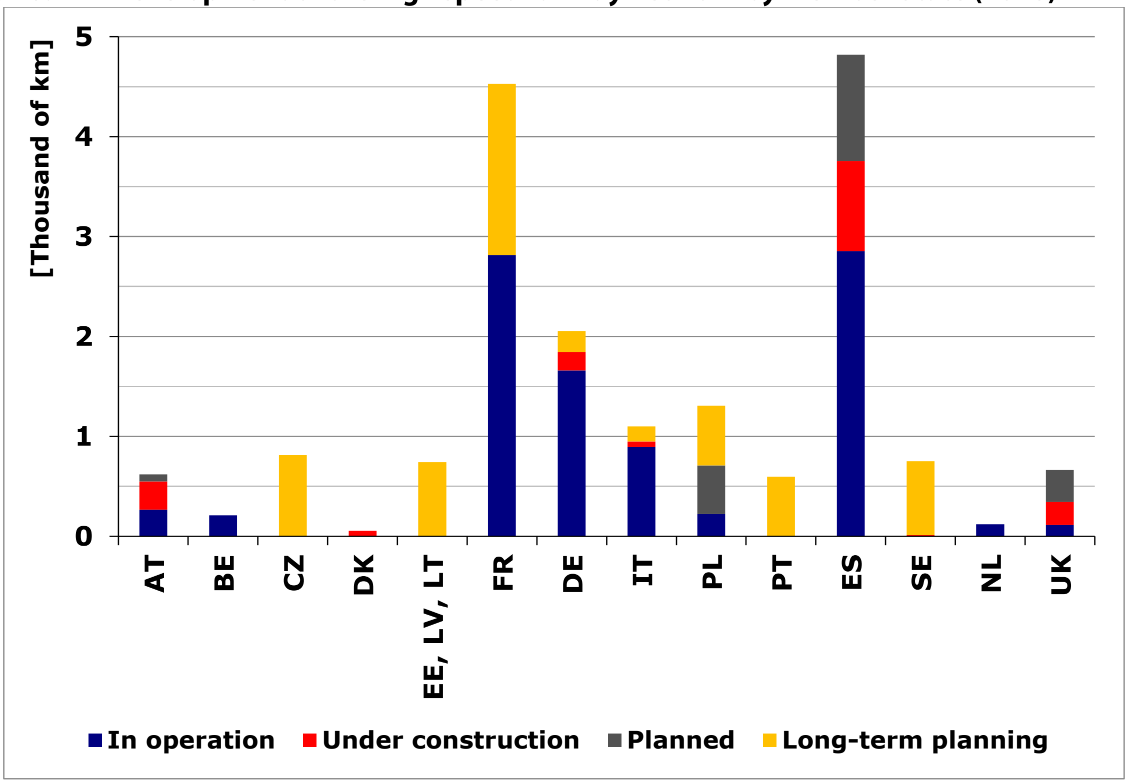
Figure 17 and Figure 18 present the state of play of the development of the high speed railway network until 2050 and by Member State, respectively.

Figure 17: Development of the high speed railway network until 2050



Source: Elaboration of the authors based on UIC (2018)

Figure 18: Development of the high speed railway network by Member State (2018)



Source: Elaboration of the authors based on UIC (2018)

A first explanation for the overall lengthy implementation of high speed railway could be the actual time needed for the relevant planning and construction activities; these can take a very long time because of design specifications and technical complexities.

Compared to conventional lines, totally new dedicated high speed railway lines require infrastructure with specific characteristics and technical requirements, such as heavier superstructures, larger curvature radii (i.e. horizontal and vertical), a smaller horizontal gradient (i.e. maximum 35‰), more resistant catenary system for electricity supply and an advanced on-board signalling system to ensure adequate headway and safety levels (i.e. ETCS, Level 2[20]). Such design constraints, in combination with the characteristics of the territory crossed may, and more often than in the case of conventional lines, need earthworks, viaducts, bridges and tunnels, thus leading to a higher cost per kilometre of infrastructure built[21]. The construction cost of totally new infrastructure can be significantly higher compared to upgrading a conventional line. For example, estimates for the 155 km section from Venice to Trieste indicate a cost of € 7.5 billion for a 300 km/h new high speed line (i.e. € 48.3 million per km), against € 1.8 billion for upgrading the conventional line (i.e. € 11.6 million per km).

Table 7 presents a summary of the overruns relating to the timing and cost of selected high speed lines, as well as the eventual cost per km for each. It is worth noting the duration of the planning and construction phases, as well as the way in which the costs escalated.

Table 7: Timing and cost overruns for a sample of high speed railway lines

High speed railway line	Length of the line [km]	Timing					Cost			
		Start of planning [year]	Start of works [year]	Start of operations [year]	Planning duration [months]	Construction duration [months]	Estimated cost [€ billion]	Actual cost [€ billion]	Overrun [%]	Average actual cost [€ million/km]
Berlin – Munich	671	1991	1996	2017	26	21	8.4	14.6	76.1	21.9
Stuttgart – Munich	267	1995	2010	2025	30	15	13.2	1.8	622.1	49.7
Rhine – Rhône	138	1992	2006	2011	19	5	2.0	2.6	26.1	18.8
LGV Est Européenne	406	1992	2002	2016	24	14	5.2	6.7	28.1	16.5
Madrid - Barcelona - France	797	1988	1997	2013	25	16	8.7	12.1	38.5	15.2
Eje Atlántico	165	1998	2001	2015	17	14	2.1	2.6	26.3	15.7
Madrid – Galicia	549	1998	2001	2019	21	18	5.7	n. a.	n. a.	14.0
Madrid – León	345	1998	2001	2015	17	14	4.1	5.4	33.3	15.7
Milan – Venice	273	1995	2003	2028	33	25	11.8	n. a	n. a.	43.4
Turin – Salerno	1 007	1987	1994	2009	22	15	10.7	31.8	200.1	31.9

Source: Elaboration of the authors based on European Court of Auditors (2018) and Beria et al. (2016)

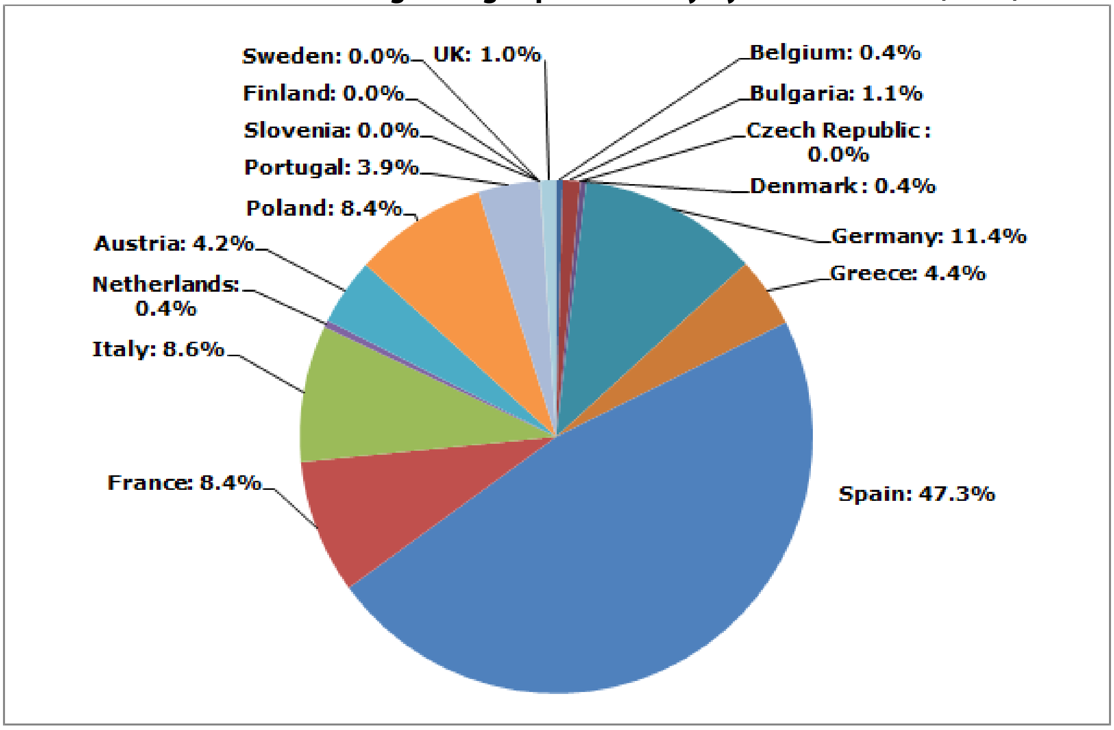
[20] ETCS is the core signalling and train control component of ERTMS, the European Rail Traffic Management System. ETCS Level 2 is a radio based system which displays signalling and movement authorities in the cab. The train is continuously sending data to the Radio Block Centre to report its exact position and direction.

[21] The maintenance costs of high speed railway infrastructure are comparable to the costs for conventional lines, but the operation and maintenance costs of the dedicated rolling stock make high speed railway networks more expensive.

According to estimates of the European Court of Auditors (ECA, 2018), over the 2000-2017 period, the European Commission has provided € 23.7 billion of co-funding grants for rail infrastructure and € 4.4 billion for the European Railway Traffic Management System (i.e. ERTMS) deployment plan. In particular, € 14.6 billion of co-funding grants (i.e. 62%) came from the European Regional Development Fund (ERDF) and the Cohesion Fund (CF), while the Connecting Europe Facility (i.e. CEF) provided € 9.1 billion (i.e. 38%). In addition, the European Investment Bank (EIB) signed loans for € 29.7 billion over the same period, making the value of the total envelope dedicated to rail equal to € 57.8 billion.

Figure 19 shows the share of EU co-funding grants earmarked for spending on high speed railway lines by Member State from 2000 to 2017[22]. It is worth noting that the EU co-funding grants are only a small fraction of the investment costs. For example, in France, Germany, Italy and Spain, which together operate around 90% of the high speed railway network in the EU, the EU grants covered on average 11.1% of the investment costs (please see Table 8 below).

Figure 19: Share of EU co-funding for high speed railway by Member State (2018)



Source: Elaboration of the authors based on ECA (2018)

Table 8: EU co-funding share rates for high speed railway investments

Country	Total cost of completed high speed railway lines [€ million]	Total cost of completed and in construction high speed railway lines [€ million]	EU co-funding for completed and in construction high speed railway lines [€million]	Share of EU co-funding
France	38 395	40 382	1 406	3.5%
Germany	28 506	34 105	2 694	7.9%
Italy	31 812	41 912	724	1.7%
Spain	31 015	53 554	14 071	26.3%
Total	**129 728**	**169 953**	**18 895**	**11.1%**

Source: Elaboration of the authors based on ECA (2018)

22 Funding for the ERTMS deployment plan and from EIB loans are not included in this figure.

Although EU funding mechanisms are put in place and various agreements amongst the Member States exist, cross-border high speed railway lines have not been implemented in a coordinated manner. In this respect, since 1996 the EU has supported the development of interoperability between national high speed railway lines to allow high speed trains to run throughout the TEN-T (European Commission, 1996a).

Specifically, to address interoperability, Directive 96/48/EC[23] (European Commission, 1996b) on common technical specifications (i.e. TSI) was adopted. Five years later, the European Parliament and the Council adopted Directive 2001/16/EC[24] (European Commission, 2001a) on the interoperability of the trans-European conventional rail system[25]. In 2008, the high speed and conventional interoperability Directives were replaced by the Directive 2008/57/EC[26] (European Commission, 2008) covering the entire European rail system.

Another important document is the ERTMS deployment plan (European Commission, 2017a)[27], which is the system designed to replace national signalling systems. Article 12.2(a) of Regulation (EU) No 1315/2013[28] (European Commission, 2013a) on the TEN-T standards stipulates that all TEN-T railway sections shall be equipped with ERTMS by 2050 and identifies this as a priority in Article 13(a). This applies, in particular, to the TEN-T core network, where the time horizon is set at 2030 and to the nine TEN-T core network corridors; the implementation of this will be monitored by a European Coordinator.

The following Boxes illustrate the main characteristics and the impact generated in terms of modal split of the high speed railway networks and services operated in France, Germany, Italy and Spain, which together have around 90% of the European high speed railway network and of passenger volumes. The networks in these countries also have important international connections with neighbouring Member States (i.e. Belgium, the Netherland and the UK).

Box 2: High speed railway in France

The high speed railway network of France reflects the structure of the country that is focused on a single centre, i.e. the capital. Paris operates as a hub, where high speed lines end at different stations, so passengers who want to travel between different French regions using high speed rail have to change station in the capital. Accordingly, the timetables of high speed services are independent. To ensure fast travel times, even between very distant cities, the commercial speed is kept close to the maximum technical threshold and dedicated stations are located in the outskirts of intermediate cities to avoid slowing trains down too much and to reduce interference from conventional rail services.

The high speed railway line from Paris to Lyon (a journey of 2 hours) resulted in a decline in air traffic on this route. According to Börjesson (2012), after the line was opened in 1981, the estimated modal split between rail and air transport was 91% against 9%. Around half of the additional rail traffic consisted of newly generated demand, but there was almost no direct substitution of car travel. For longer connections, such as from Paris to Marseille (around 4 hours and 45 minutes) rail and air transport modes have a 50%-50% modal split.

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23 Council Directive 96/48/EC of 23 July 1996 on the interoperability of the trans-European high speed rail system.

24 Directive 2001/16/EC of the European Parliament and of the Council of 19 March 2001 on the interoperability of the trans-European conventional rail system.

25 Both directives were later amended in 2004 (European Commission, 2004) and 2007 (European Commission, 2007a), respectively.

26 Directive 2008/57/EC of the European Parliament and of the Council of 17 June 2008 on the interoperability of the rail system within the Community (Recast).

27 Please see also European Commission (2016a, 2016e).

28 Regulation (EU) No 1315/2013 of the European Parliament and of the Council of 11 December 2013 on Union guidelines for the development of the trans-European transport network and repealing Decision No 661/2010/EU.

At the international level, France is linked to Belgium and the UK. From Paris to Brussels (only 1 hour and 30 minutes), high speed trains transport around 95% of passengers. The share of high speed railway passengers travelling between Paris and London through the Channel Tunnel is 71% (on a journey of 2 hours and 15 minutes) (Börjesson, 2012; Silver Rail, 2016; UNECE, 2017).

Box 3: High speed railway in Germany

In Germany, the urbanisation pattern has many centres. While the capital Berlin has almost 4 million inhabitants, several other cities, all around 100 km apart, have 1 or 2 million inhabitants. Within this pattern, the high speed railway network operates around several transport nodes, where passengers have to change (at one, or more stations) to reach the final destination. Moreover, high speed services are linked, not only with each other, but also with conventional services at stations close to city centres (Grein, 2014).

These characteristics suggest that: (i) the (maximum) technical speed is not the primary factor, but rather one of the factors for optimising interconnections; and (ii) the interchange at transport nodes (i.e. cities or airports) is another important factor for ensuring intermodality with both feeder rail services and other transport modes (e.g. coaches).

High speed services have replaced the flights that operated between Frankfurt and Köln/Bonn airports. On average, the modal split is estimated to be in the range of 50%-60% for the high speed services operated between Frankfurt, Stuttgart, Hamburg, Munich and Berlin (Börjesson, 2012; Grein, 2014). Cheng (2010) suggests that the high prices of high speed services, the low level of competition with air transport and more the regional organisation of transport infrastructure could explain the lower modal split observed in Germany compared to that in France.

At the international level, Germany is connected with Belgium and the Netherlands, i.e. to Brussels and Amsterdam. The German incumbent rail undertaking "DB" is considering launching high speed rail operations from Frankfurt to London via the Channel Tunnel (Economist, 2015; Rail Gazette, 2018).

Box 4: High speed railway in Italy

Italy has developed a "T-shaped" high speed railway network, with a backbone line from Turin to Naples/Salerno, via Milan, Bologna, Florence and Rome, on which most cities are 150-250 km apart. This shape replicates the north-south mobility flows in the country, through the cities generating the core demand. The short-distance demand segment (i.e. less than 200 km) is dominant compared to the medium- or long-distance ones. In particular, the section from Bologna to Rome has the highest volume of passengers (i.e. around 18 million per year), while the level of use is lower for the ends of the line, namely from Milan to Turin and from Rome to Napoli (Desmaris, 2016; UNECE, 2017).

The level of use has increased over time driven by: (i) the implementation of the network (fully operational in 2009); and (ii) the introduction of competition in the high speed rail market. This occurred in 2012, when a new operator "NTV" entered the Italian market, which pushed the incumbent "Trenitalia" to compete on ticket price, frequency and service quality. It is estimated that: (i) the 2015 market shares of "Trenitalia" and "NTV" were 77% and 23%, respectively (Desmaris, 2016); and (ii) the competition between the two rail undertakings has reduced ticket prices on average by 30% between 2011 and 2012, although this could also be partially explained by an increase of productivity (Preston, 2013).

The implementation of the high speed railway network in Italy also induced a modal shift. In particular, on the section from Milan to Rome, where the travel time by air or high speed railway is comparable, which makes the modes good alternatives to each other. Over the period 2008-2014, the modal share of high speed rail on this section increased, from 36% to 65%, while air and road shares reduced from 50% to 24% and from 14% to 11%, respectively (Autorità di Regolazione dei Trasporti, 2015). It is worth observing that a number of factors may have contributed to this modal shift, including: (i) that the rail demand for conventional services dropped when the high speed railway was opened; (ii) the dire financial troubles affecting the operations of the airline "Alitalia"; and (iii) that the low cost airline "easyJet" decided to enter and then suddenly abandon the route linking Milano Linate and Roma Fiumicino airports.

From Italy, there are no international services operated on dedicated high speed railway lines, because the Italian high speed network is not linked with neighbouring Member States[29]. The major ongoing (and controversial) cross-border project is the construction of the line from Turin to Lyon through the Alps.

Box 5: High speed railway in Spain

As in France, Spain has developed a radial high speed rail network, connecting Madrid with the other main cities located in the southern part of the country and on the Mediterranean coast[30].

The implementation of the high speed railway lines have had positive impacts on modal shift. For the line from Madrid to Seville, figures from 1991 indicated that road was the dominant mode (enjoying a 44% share in the market), followed by air (40%) and rail (16%). In 2012, i.e. ten years after the high speed railway line became operational (with a journey time of 2 hours and 15 minutes), the modal split changed in favour of high speed rail (61%), followed by road (30%), air (8%) and conventional rail (1%). However, this change cannot be fully attributed to high speed services per se, because the national airline decided not to compete with high speed railway[31]. For the line from Madrid to Barcelona (a journey of 2 hours and 40 minutes), once it was completed, the total rail share compared to air increased from 12% to 48%. Comparable changes have been also observed for the high speed railway lines from Madrid to Valencia and Malaga (i.e. increase from 40% to 75%, and from 28% to 69%, respectively (Texas HSR Org, 2012).

However, some of new high railway speed lines have proven to be neither economically viable, nor financially sustainable (De Rus, 2012), because they were: (i) implemented in a territory characterised by low population densities (thus generating little demand); (ii) connecting cities separated by long distances; and (iii) implemented along routes in competition with air transport. These aspects have forced the Spanish incumbent rail undertaking to keep prices artificially low in an attempt to improve the load factor, but in turn, this has made the infrastructure financially unsustainable. Another issue is the variety of train types in use, which negatively affects operating costs (Beria et al., 2016). As other research has previously highlighted (Albalate and Bel, 2011; Albalate et al., 2015), the implementation of high speed railway lines appears excessive compared to the actual demand.

The line towards the border with France, through Figueras and Perpignan, is the only cross-border high speed rail connection. Portugal has planned to implement a connection to Spain (via Caia), but only in the long-term (UIC, 2018).

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29 High speed tilting rolling stock operates from Italy to Switzerland on conventional lines, with a maximum speed of 250 km/h.

30 The new high speed railway lines have been designed with a standard UIC gauge (1 435 mm) instead of the Iberian gauge (1 668 mm). High speed railway lines are connected with the Iberian gauge network by special gauge chancing device in many places. This allows dual-gauge equipped trains to travel to destinations on the Iberian gauge branch lines.

31 Airlines are now deregulated in Spain and air services could be more competitive between major domestic airports.

3.1.5. Level of cross-border interoperability

At its most basic level, interoperability is defined as the ability of a system or a product to work with other systems or products without special effort on the part of the customer.

More specifically in the **rail industry**, interoperability is defined by the European Commission as the ability of a rail system to allow the safe and uninterrupted movement of trains in order to achieve the required levels of performance for these lines. In the European framework, interoperability is being achieved through a series of technical-regulatory interventions initiated by the Commission that aim to bring the various national railway systems together in a railway network which is open and integrated at the European level. A number of regulatory, technical and operational conditions must be met in order to satisfy the essential requirements for interoperability (please see Box 6 for the main elements of the current EU regulatory framework).

Box 6: The EU rail interoperability

At the end of 1990s, the EU started the process that aimed to deliver interoperability in the EU rail sector. In order to contribute to this, Directive 96/48/EC[32] (European Commission, 1996b) on the intermodality of trans-European HSR and Directive 2001/16/EC (European Commission, 2001a) on the intermodality of conventional rail were adopted. In the frame of these Directives, different technical solutions (known as "Technical Specifications for Interoperability" or TSIs) have been elaborated concerning a wide range of issues, such as rail safety, signalling systems, telematics applications for freight transport, noise pollution, training for those staff responsible for cross-border transport, etc. In the 2000s, the two abovementioned Directives were modified and updated by Directive 2004/50/EC (European Commission, 2004), which extended the coverage of the requirements to the whole EU rail system, with the aim of opening up the rail network to national and international freight transport services in January 2007 and to passenger transport services in January 2010 (Ratcliff, 2018).

Directive 2008/57/EC, modified subsequently by Directives 2009/131/EC and Directive 2011/18/EU, merged the previous Directives into a unique text. In the frame of the 4th Railway Package, Directive 2008/57/EC has since been merged with Directive 2016/797[33] regarding the interoperability of the rail system in the EU.

Despite the numerous interventions and policy measures that have been implemented at the EU level, there is still a long way to go to achieve full rail interoperability between the Member States. Rail transport is highly dependent on the technical compatibility of infrastructure and the trains that run on it. Cross-border rail is still problematic, as services arriving at a border often still need to change locomotives and crew, as a result of various agreements, including those with trade unions.

The so-called "Rastatt incident", which interrupted the Rhine Valley freight route from the 12 August to the 7 October in 2017, underlined that a lot of work still needs to be carried out to achieve effective interoperability at the corridor and the network level, due to the challenges with potential alternative routes. Firstly, many locomotives were not equipped to operate on the railway network in neighbouring EU countries and train drivers did not have the necessary language and technical skills to operate a train in another country. Secondly, the capacities on the alternatives routes for rail freight traffic along the Rhine-Alpine corridor were not sufficient to deal with the sudden and unexpected additional traffic.

32 Council Directive 96/48/EC of 23 July 1996 on the interoperability of the trans-European high speed rail system.

33 Directive (EU) 2016/797 of the European Parliament and of the Council of 11 May 2016 on the interoperability of the rail system within the European Union (recast).

In the European rail system there are over 20 different national signalling and speed control systems and each one is incompatible with the others (Galushko and Davenne, 2016). The co-existence of all of these systems creates an obstacle to the free flow of rail traffic across the EU and reduces the competitiveness of the rail sector.

An insight into how the different systems have come about can be found in the development of high speed railway networks, as currently there is no integrated European high speed railway network, as noted above. Member States have developed relatively independent high speed railway networks, with their own signalling systems and a variety of technical solutions for power supply (i.e. voltage) and even different track gauges. This also suggests that completing the cross-border sections by linking national networks is not a priority at the national level, even when developing new infrastructure.

Existing technical differences are barriers to interoperability, and will become an issue as the high speed railway network and services develop further. Table 9 presents a sample of international links in the EU that are operated with different signalling systems and voltages.

Table 9: International rail links operated with different voltages and signalling systems

Countries crossed	Operator(s)	Signalling systems	Voltages [kV]
France, Belgium and the UK	Eurostar	TMV/KVB, TBL, AWS/TPWS	0.75, 3.0 and 25 (50 Hz)
France, Belgium and the Netherlands	Thalys	TMV/KVB, TBL, ATB, ETCS	1.5, 3.0 and 25 (50 Hz)
Germany and the Netherlands	DB AG, NS	PZB/LZB, ATB, TBL	1.5, 3.0, 15 (16.7 Hz) and 25 (50 Hz)
Germany and Austria	DB AG, ÖBB	PZB/LZB, ZUB	15 (16.7 Hz)

Source: UIC (2018)

At the national level, high speed railway lines have been designed in different ways, not only technologically, but also depending on the physical characteristics of the territories crossed and the location of the major urban agglomerations, as noted above.

A potentially important step that paves the way for better interoperability at the European level should be the implementation of the European Rail Traffic Management System (ERTMS; please see Box 7 below).

Box 7: The European Rail Traffic Management System (ERTMS)

ERTMS is a major industrial programme aimed at harmonising the automatic train control and communication systems and underpinning interoperability throughout the rail system in Europe, especially on the new European high speed rail networks (European Commission, 2008).

Currently, ERTMS is deployed inconsistently, with many stretches not connected to each other (ECA, 2017). Virtually all of the Italian and Spanish high speed rail networks are managed and protected by ERTMS, and the same applies to significant parts of the Swiss, Dutch and Belgian networks. Trains operate in commercial services at 320 km/h with ETCS, which controls freight trains on conventional lines, and on dedicated routes. The longest Alpine tunnel is equipped exclusively with ERTMS. The system is also in use on some suburban lines with commuter traffic (e.g. Madrid).

The current status of ERTMS deployment can mainly be explained by the reluctance of many infrastructure managers and railway undertakings to invest in ERTMS equipment due to its high costs (ECA, 2017).

Even if the EU is trying to introduce common standards, e.g. for ERTMS, there are still lots of barriers if a train wants to travel from Germany to Spain. While the EU legislation that has been put in place has resulted in some degree of harmonisation, the process has not gone far enough. For example, ERTMS has been fitted on trains in Italy, but this has not been implemented in Germany and France, as they already have their own traffic management systems. The introduction of ERTMS would bring several benefits, including allowing an increased capacity on existing lines and a greater ability to respond to growing transport demands, an open supply market and, as a result, facilitating a wider opening of the networks.

Cross-border interoperability and accessibility is also hindered at the regional and local level due to missing links and infrastructure bottlenecks on the borders of several Member States. "Missing links", i.e. non-operational small-scale cross-border railway connections, within the European Union have gained increasing attention from European policy-makers in the recent years. A study focusing on passenger rail accessibility identified 365 cross-border rail connections across the EU's internal borders; currently, 149 of these were non-operational (41%). Border regions – both those next internal and external borders – account for one-third of the EU population (Poelman and Ackermans, 2017), so these are important from the perspective of potential demand for cross-border rail services. However, only 44% of the population in all border regions has access to cross-border passenger rail services (Sippel et al., 2017).

Unlike the rail sector, the **road transport** industry has taken full advantage of the EU's actions to open the road transport market to reinforce its position. Due to the nature of road infrastructure, interoperability is much less of an issue as it relates more to very specific, technical aspects, such as road charging and tolling. The main efforts in recent years have been aimed at harmonising and making the various tolling systems in the EU more interoperable, in order to smooth traffic flows. Based on a proposal[34] from the Commission, the European Parliament's TRAN Committee adopted its report[35] for a single European electronic motorway toll network in May 2018. The vote comes after years of technical and parliamentary work to take account of the different realities of the network of European motorways. The aim is to set up a system enabling the interoperability between the various tolling systems available in the various Member States. An agreement is yet to be reached between the Parliament and the Council on the final version of the legislation. Further details on the charging schemes applied and problems of interoperability are described in section 3.2. However, the absence of interoperability to date for charging and tolling has only been an inconvenience for road transport, rather than a significant barrier as is the case for rail.

In relation to **inland waterways**, barriers to interoperability have been identified and are being addressed by the Commission, as reported in Directive 2005/44/EC[36]. The lack of availability and the lack of transparency of information on freight flows, in combination with limited ICT facilities, as well as a lack of standards for communication and information exchange have been identified as the most important technical barriers to the sector's interoperability. Such inefficiency is mainly due to the costs to make the communication systems and planning tools interoperable between multiple actors in the multimodal transport system. As a result, long waiting times for barges in seaports occur, hampering a wider implementation of multimodal hinterland transport.

[34] Communication from the Commission, Developing the trans-European transport network: Innovative funding solutions Interoperability of electronic toll collection systems. Proposal for a Directive of the European Parliament and of the Council on the widespread introduction and interoperability of electronic road toll systems in the Community.

[35] Report on the proposal for a Directive of the European Parliament and of the Council on the interoperability of electronic road toll systems and facilitating cross-border exchange of information on the failure to pay road fees in the Union (recast) (COM(2017)0280 – C8-0173/2017 – 2017/0128(COD)).

[36] Directive 2005/44/EC of the European Parliament and of the Council of 7 September 2005 on harmonised river information services (RIS) on inland waterways in the Community.

3.2. Access charges to transport infrastructures

An access charge is the price paid for the use of a piece of transport infrastructure; it generally reflects the cost incurred in building, maintaining and operating the infrastructure.

Infrastructure access charges are important for two reasons: first, the type and level of the access charge determines the level of demand compared to the capacity of the infrastructure, thus ensuring that the infrastructure is used in the most efficient way and so maximising social welfare; second, infrastructure access charges determine the amount of revenues that can be allocated for maintenance, operation and new investments.

The infrastructure access charge is not the only component of transport pricing, because the price the vehicle owner faces will also include taxes, and may also be affected by any additional levies and subsidies. Transport pricing is also used to internalise the external costs that result from the transport operations (e.g. the cost that the users do not perceive, such as emissions of pollutants and congestion, etc.).

Access charges should be set accordingly to the Marginal Social Cost Pricing (MSCP) principle[37] (Proost and Van Dender, 2003), in order to achieve the allocative efficiency, but the nature of infrastructure, services and external costs, as well as spatial and temporal variation of costs, influence the actual level of the access charges.

The 2011 White Paper on transport remarks that users should pay the MSCP related to the use of transport infrastructure, because if the pricing in place does not correctly reflect the total cost borne by the society, transport demand cannot be allocated efficiently and the pricing cannot work as a tool to shift users to more efficient and sustainable transport modes.

The 2011 White Paper on transport envisaged a gradual approach to achieving allocative efficiency. The first phase, which was to be implemented by 2016, focused on restructuring transport charges and taxes in order to reflect the total costs of transport in terms of infrastructure charges and external costs. The second phase, from 2016 to 2020, was envisaged for the implementation of the full and mandatory internalisation of external costs for road and rail transport.

Regarding the actual implementation of the measures envisaged by the 2011 White Paper on transport, the 2016 Commission's report (European Commission, 2016f) acknowledges that the transition and restructuring of the access charges towards the "user pays" and "polluter pays" principles is expected to be more gradual and long-term than was initially envisaged. Notably, the initiative for the internalisation of external costs by 2020 still needs to be implemented.

The following sections of this chapter illustrate the main characteristics of infrastructure access charges of for road, rail, aviation and maritime transport, illustrating to what extent the principles of the 2011 White Paper on transport have been applied and their likely evolution.

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[37] When the marginal social cost pricing rule is used, prices are equal to the sum of the marginal resource cost (extra cost of driver time, fuel, wear and tear of vehicle, all before taxes) and the marginal external cost (including congestion, air pollution, noise, accidents and maintenance cost of the infrastructure), for a given infrastructure.

3.2.1. Road

There are three types of access charges for roads applied across the EU, namely:

- distance-based access charges, typically a unit toll per kilometre[38] of infrastructure multiplied by the distance travelled;
- time-based access charges[39] or "vignettes", paid to buy the right to access a road for a certain time; and
- tolls paid for use of specific sections of the network, such as tunnels or bridges.

There are advantages and disadvantages of both distance- and time-based access charges. A distance-based charge is not easy to implement, because it requires the creation of additional barriers for manual or electronic toll collection, or the installation of roadside equipment for electronic collection. A time-based vignette requires users to take the time to purchase the stickers when necessary[40] and also needs enforcement rules and procedures. Both types of access charge may internalise infrastructure costs (i.e. investment, maintenance and operating costs), but the vignette is not an effective measure for managing demand or for internalising a context-specific external cost, such as congestion (Booz&Co, 2010; European Commission, 2012b).

There are also different regimes for the different vehicles that are subject to road access charges, i.e. for: (i) light private vehicles[41], coaches and buses; and (ii) heavy goods vehicles (HGVs)[42]. The rules for the former stem from the Treaty on the Functioning of the EU (TFEU) (European Commission, 2012a), while specific Directives have been issued to govern the access charges of HGVs (European Commission, 1999a; European Commission, 2011b).

For light private vehicles, currently, eight Member States have adopted distance-based access charges, seven use vignettes and 13 neither distance-based charges nor vignettes[43]. Map 8 below shows that the types of access charges tend to be geographically clustered. With the exception of Austria, the EU-15 Member States have adopted either distance-based, or no charges at all. In the EU-13 Member States, time-based charges are predominantly used, with the exception of Croatia and Poland (which have distance-based tolls) and the Baltic States (i.e. where no charge is applied).

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38 Please see Article 2(b) of Directive 1999/62/EC of the European Parliament and of the Council of 17 June 1999 on the charging of heavy goods vehicles for the use of certain infrastructures (European Commission, 1999a).

39 Please see Article 2(c) of Directive 1999/62/EC (European Commission, 1999a).

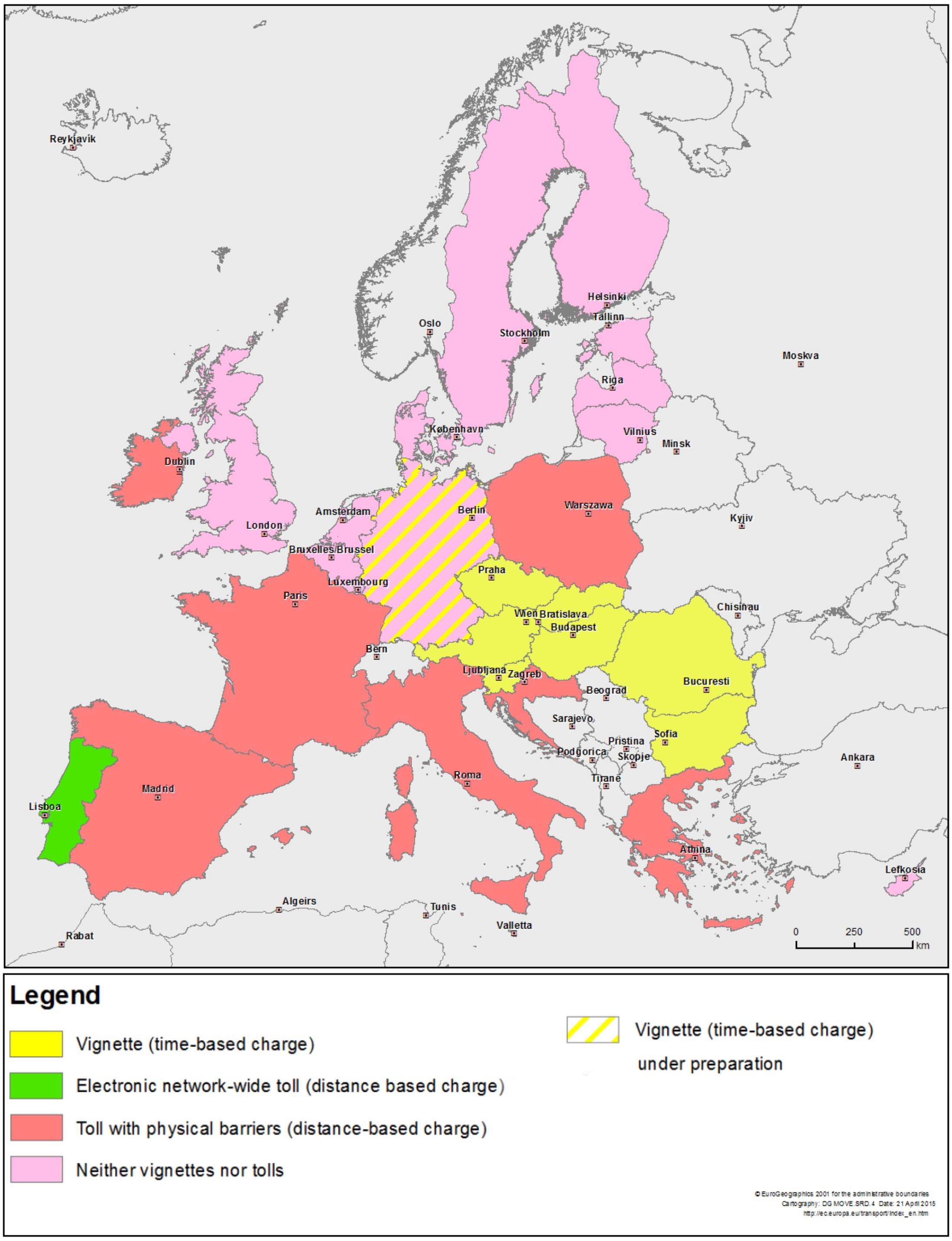
40 The vignette is similar to the vehicle's ownership tax. The advantage of the vignette is that its value better correlates with duration reflects the actual period of time for which it has been bought, while the annual ownership tax is a long-term fix cost that can be paid even for a negligible use of a vehicle.

41 Passenger cars, motorcycles and light commercial vehicles with total permissible mass of no more than 3.5 tonnes.

42 With total permissible mass of more than 3.5 tonnes.

43 Germany is preparing a vignette access charge (i.e. "Pwk-Maut").

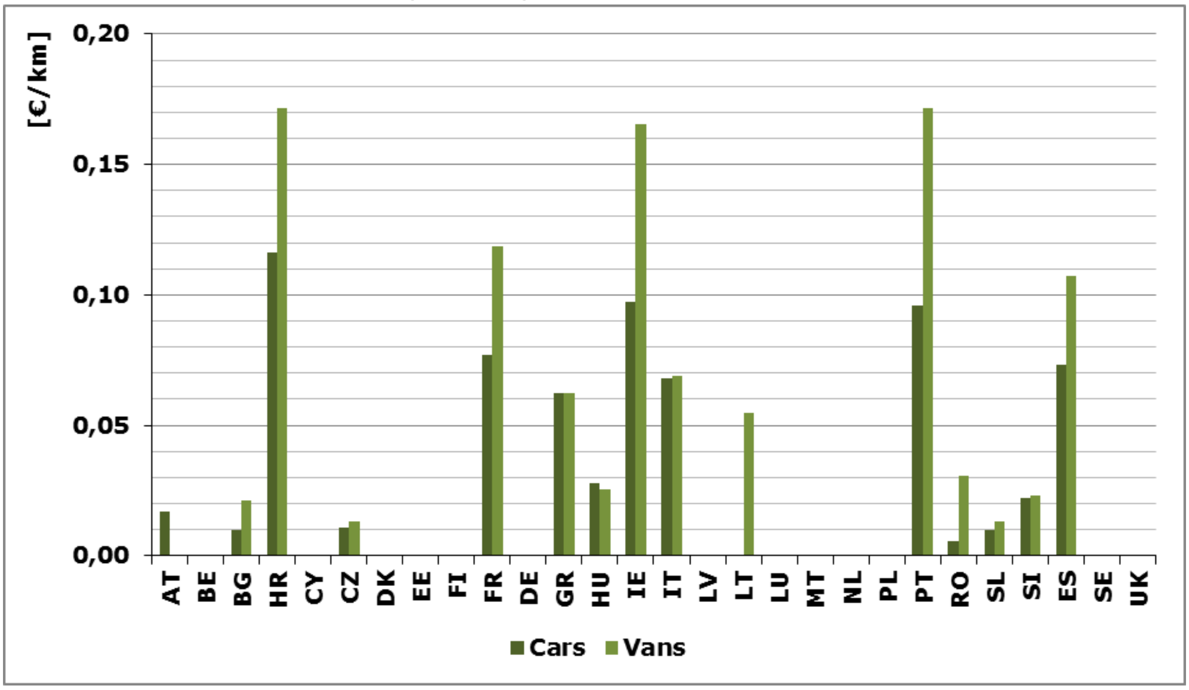
Map 8: Road infrastructure charges for light private vehicles in the EU



Source: European Commission (2018)

Figure 20 below presents estimates of the level of access charges for light private vehicles in different Member States. In terms of the price paid per kilometre of infrastructure travelled, distance-based charges tend to be higher than vignettes. For cars, on average across the EU-28, distance-based access charges are nearly six times higher than time-based charges (i.e. € 0.084 and 0.015 per kilometre, respectively). For vans, the ratio is similar, but with higher unit rates (i.e. € 0.124 and 0.021 per kilometre, respectively).

Figure 20: Road infrastructure charges for light private vehicles [€/km]



Source: Authors' own elaboration based on data from Gibson et al. (2017)

There is also a diversity of regimes for **heavy goods vehicles (HGVs)**. Distance-based access charges, collected through electronic tolling, are levied in seven Member States, namely in Austria, the Czech Republic, Germany, Slovakia, Poland, Hungary and Portugal. Some of these network-wide tolling systems also include other roads in addition to motorways. The first system to become operational was the Austrian "Maut", introduced on 1 January 2004. The German "Maut" followed one year later. The Czech Republic started its electronic tolling system on 1 January 2007, while Slovakia and Portugal launched their systems in 2010 with Poland following in 2011. The most recent electronic tolling system was implemented in June 2013 in Hungary (please see Map 9 below).

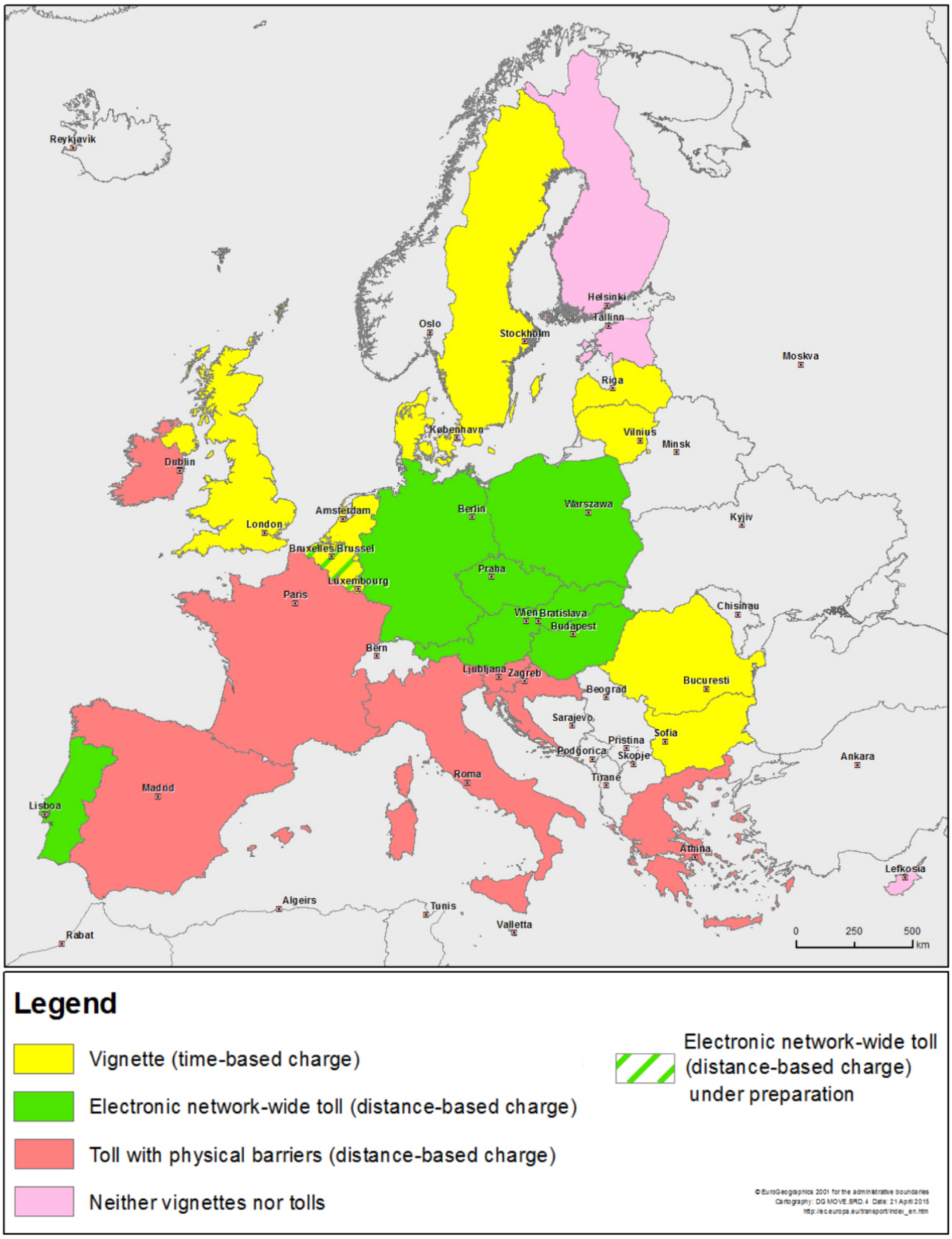
The Eurovignette is levied on vehicles over 12 tonnes which use motorways and some other roads in Belgium, Denmark, Luxembourg, the Netherlands and Sweden. Since 2008, paper vignettes have been replaced by electronic vignettes (i.e. e-vignettes), which are linked to the number plates of HGVs, and are controlled by automatic number plate recognition (i.e. ANPR). In Belgium, the regional authorities reached a political agreement in January 2011 to replace the Eurovignette with a distance-based access charge that would be applied on the TEN-T road network, motorways and other main roads. Vignettes are also used in Bulgaria, Latvia[44], Lithuania, Romania and the UK[45] on motorways and other national roads.

Other Member States, such as Croatia, France, Greece, Ireland, Italy, Slovenia and Spain, also use distance-based access charges. Tolls can be paid at gates either manually or electronically. HGVs are not charged to use any road infrastructure in Cyprus, Finland and Malta.

[44] The charge toll is paid for certain sections of the main state roads, depending on the: (i) time period, (ii) vehicle maximum permissible weight, (iii) number of axles and (iv) EURO class.

[45] A levy is required for HGVs that weighs more than 12 tonnes. Prices vary according to Euro class. Tolls along the M6 motorway are collected at physical barriers. Other charges are applied for certain bridges and tunnels.

Map 9: Road infrastructure charges for HGVs in the EU



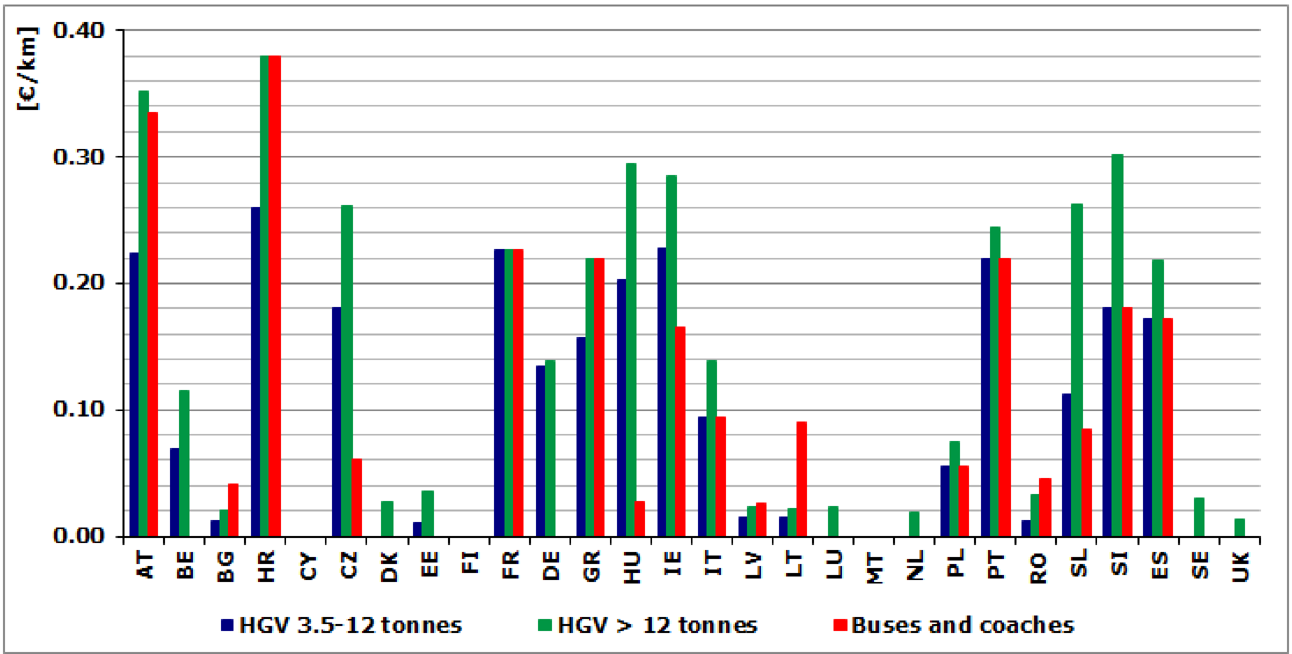
Source: European Commission (2018)

Figure 21 below presents the estimations of access charges for HGVs with a maximum load of more than 3.5 tonnes, as well as for buses and coaches. As in the case of light private vehicles, the unit charge of distance-based tolls for HGVs is higher than that of vignettes[46].

[46] It is worth noting the relatively high unit charges found in Croatia for both light private vehicles and HGVs. This can be explained by the investment programme for the road network implemented during the second half of the 1990s and the first decade of this century (Božičević et al., 2008). This investment programme was planned to reconstruct damaged infrastructure after the civil war, and to modernise existing and to build new infrastructure.

For HGVs with a weight between 3.5 and 12 tonnes, on average across the EU-28 level, distance-based charges are 34% higher than time-based charges (i.e. € 0.177 and 0.132 per kilometre, respectively). For HGVs heavier than 12 tonnes, the difference is 2.5%, but with higher rates levied (i.e. € 0.223 and 0.218 per kilometre, respectively). Finally, for buses and coaches, the difference is 74% (i.e. € 0.192 and 0.110 per km, respectively).

Figure 21: Road infrastructure charges for HGVs [€/km]



Source: Authors own elaboration based on data from Member States vignette websites and Gibson et al. (2017)

The review of road access charges per kilometre highlights two points for further consideration.

First, a variety of distance- and time-based access charges are used across the Member States and, at the national level, different schemes may exist for light private vehicles and HGVs. This suggests that the approach to charging is not homogeneous across the EU. Although, a transition to either distance-based or time-based systems can be observed in recent years, the actual implementation has slowed, or even been postponed. Therefore, the future situation with respect to road access charge schemes in the EU cannot be depicted with certainty.

Second, relatively significant differences exist between time-based and distance-based access charges. To some extent, these can be explained by the different vehicle taxation schemes and regulatory regimes of road infrastructure at the national level, but also by differences in the application of the "user pays" and "polluter pays" principles. In particular, the difference between time- and distance-based unit access charges may suggest that vignettes do not sufficiently apply the "user pays" and "polluter pays" principles.

Box 8 below summarises the recent changes that have been introduced, or which are envisaged in the future, for HGVs.

Box 8: Evolution of charges for HGVs in the EU (changes introduced or planned)

Since April 2016, a distance-based charge for HGVs of over 3.5 tonnes has been in place in **Belgium** as part of a programme to reform the method of financing road infrastructure. The access charge to be paid depends on the weight of the HGV, its emission class and the type of road used (VIA, 2016).

The Roads Infrastructure Agency of **Bulgaria** has developed an implementation plan for the deployment of, and legal changes to enable, the commencement of e-vignette operations in 2019 (Bulgarian-Romanian Chamber of Commerce and Industry, 2018).

In **Estonia**, since 1 January 2018, it has been obligatory for all HGVs that weigh over 3.5 tonnes to pay a charge for the use of the public roads network. The toll rate depends on the total weight of the HGV and its trailer, its number of axles and its emission class (IRU, undated).

In 2013, **France** planned to introduce the so-called "Ecotaxe" on 10 500 km of toll-free highways motorways and on about 5 000 km of secondary roads. After facing severe opposition from truck drivers, the Government abandoned the initial goal by imposing a far less ambitious "transit truck toll", staring from 1 January 2015[47].

Since 1 July 2018, **Germany** has widened its charging scheme for HGVs to 40 000 km of federal motorways[48], largely as a result of the urgent need for structural maintenance and upgrading of the transport network. According to BMVI (2018), by varying the charges according to the pollutants the vehicles emit, the scheme could incentivise hauliers to use fewer polluting vehicles and supports a modal shift.

Since 1 July 2014, a road charging system has been in place in **Latvia** (IRU, 2016). The charge is paid for the use of certain sections of the main state roads by HGVs that have a maximum total laden weight that exceeds 3.5 tonnes. The calculation of the charge depends on the time period, the vehicle's maximum permissible weight, its number of axles and its emissions class.

The **Netherlands** has traditionally been the biggest defender of the time-based vignette system. In October 2017, however, the Dutch Government committed itself to introduce a distance-based charge for HGVs, accompanied by a reduction in road tax. Currently, the implementation date is uncertain, and it may not be before 2023 (Transport & Environment, 2017).

As of 1 April 2018, **Slovenia** has a distance-based electronic charging system for vehicles with a maximum permissible weight over 3.5 tonnes. The access charge is calculated on the basis of emission class and the number of axles.

Sweden is expected to replace its current vignette system in the future. The Government has committed to introducing a distance-based access charge for HGVs, but progress has been stalled and the new system will not come into force before 2019 at the earliest. The legal prerequisites for road user charging have been already analysed (ARENA, 2014).

Since 1 April 2014, all operators of HGVs, at or above 12 tonnes, using the **UK's** roads are required to pay an HGV road user levy (Department for Transport, 2017).

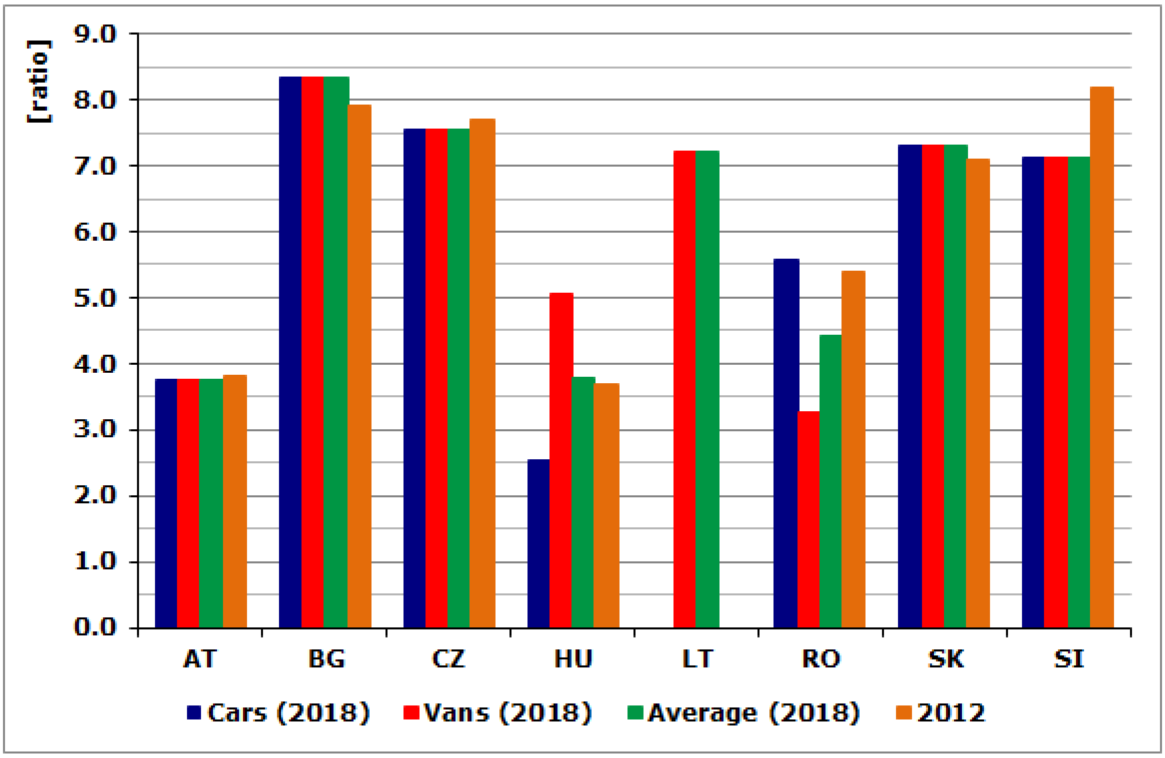
[47] The "transit truck toll" applies on 4 000 km road network with traffic levels of more than 2 500 trucks per day. This distance-based charge is modulated with respect to the emission class, according to the dossier "Remplacement de l'écotaxe par un péage de transit poids lourds pour les routes au trafic supérieur à 2 500 poids lourds par jour", 23 June 2014.

[48] HGV charging on federal motorways was introduced in 2005. In doing this, Germany moved from using HGV taxes to contribute to the general budget to applying the "user pays" principle, as the revenue is now used to finance road construction. The charging scheme has been widened in two stages (on 1 August 2012 and 1 July 2015) to cover around 2 300 km of four-lane federal motorways. In addition, on 1 October 2015, the weight threshold for vehicles subject to charges was lowered from 12 to 7.5 tonnes.

It is also worth noting that, in order to be proportional and non-discriminatory[49], a vignette should be set at a rate that reflects the actual use of the infrastructure (e.g. to avoid penalising non-resident or occasional drivers). For HGVs, Directive 1999/62/EC[50] sets maximum relative prices for daily, weekly and monthly rates[51]. In particular, the monthly rate shall be no more than 10% of the annual rate, the weekly rate shall be no more than 5% of the annual rate and the daily rate shall be no more than 2% of the annual rate. There are no similar provisions for light vehicles (European Commission, 2012b).

Figure 22 below presents the ratios of the price of short-term vignettes compared to long-term vignettes for light vehicles[52]. The ratios range from 3.8 to 8.3, which are low compared to the implied ratios for HGVs set by the Directive 1999/62/EC (which range from 10 to 50, as noted in the previous paragraph). These differences cannot be explained by economies of scale, as the implementation, administrative and enforcement costs for one type of vehicle can be assumed to be independent from other vignettes. In addition, comparing the 2018 ratios with those of 2012 in Gibson et al. (2012), it is clear that the situation has not changed significantly over these six years (please see also Table 27 in Annex E).

Figure 22: Ratio of short- and long-term vignette prices and comparison between 2012 and 2018[53]



Source: Elaboration of the authors based on data derived from Member States vignette websites and Gibson et al. (2017)

49 Any discrimination of EU citizens on the grounds of nationality is prohibited by Article 18 of the Treaty of the Functioning of the European Union (TFEU). Since the Treaty does not contain any special provisions concerning private transport, any vignette system for light private vehicles should be assessed in light of Article 18 of the Treaty.

50 Directive 1999/62/EC of the European Parliament and of the Council of 17 June 1999 on the charging of heavy goods vehicles for the use of certain infrastructures.

51 Please see Article 7a(1), as amended by Directive 2006/38/EC of the European Parliament and of the Council of 17 May 2006 amending Directive 1999/62/EC on the charging of heavy goods vehicles for the use of certain infrastructures and Directive 2011/76/EU of the European Parliament and of the Council of 27 September 2011 amending Directive 1999/62/EC on the charging of heavy goods vehicles for the use of certain infrastructures.

52 Calculated as the ratio between average cost per day of short-term vignette and the average cost per day of long-term vignette.

53 In Lithuania, a vignette is charged on vehicles up to 3.5 tonnes (i.e. VANs). According to Lithuanian Road Administration, this category is assumed as part of the scheme charged to HGVs and not on light vehicles.

3.2.2. Rail

Directive 91/440/EEC[54] (European Commission, 1991) was the first piece of EU legislation that introduced access charges for international freight railway undertakings. Currently, Directive 2012/34/EU[55] (European Commission, 2012c) provides the legal basis for establishing the principles governing access charges for rail; it requires Member States to establish frameworks that comply with the management independence principle[56] laid down in Directive 91/440/EC.

The charging framework has been conceived to incentivise the optimal use and provision of railway infrastructure. According to Article 31(3) of Directive 2012/34/EU, access charges must be set at the "*cost that is directly incurred as a result of operating the train service*". This principle applies to the so-called "minimum access package" and establishes that the methodology for the calculation of the cost shall be that as defined by Regulation (EU) 2015/909[57] (European Commission, 2015c). It is also worth noting that access charges can be levied to: (i) address scarcity or capacity limitations of part of the network due to congestion (please see Article 31(4)); or (ii) take account of environmental effects (please see Article 31(5)).

Directive 2012/34/EU allows for exceptions to the above-mentioned principles. First, to achieve full cost recovery, infrastructure managers can introduce a mark-up. Second, for (i) future investments, or (ii) specific investments that have been completed after 1988, the infrastructure manager can establish higher charges to recover the long-term costs of the investments that have been undertaken[58].

At the EU level, the approach commonly used by infrastructure managers is to identify the level of access charges by differentiating them with respect to train type (e.g. high speed, conventional passenger and freight), the location of the line or node in the network and the time of the service provided (e.g. day or night). In general, the calculation is based (at least partly) on the principle of marginal cost pricing (IRG-Rail, 2016)[59], although the methodologies to calculate the marginal cost can vary between Member States (please see also Box 9).

Box 9: Marginal cost calculation

According to the research of Lindberg and Gunnar (2009) the short-run marginal cost can be considered as the threshold below which the rail access charges should not be set. The research found that the marginal cost can vary considerably depending on a number of factors, particularly infrastructure quality and traffic density and mix of passengers and freight trains.

The marginal cost can be calculated starting from the average infrastructure cost[60] and assuming elasticity measures, which express the percentage variation of the cost with respect to a percentage variation of the traffic.

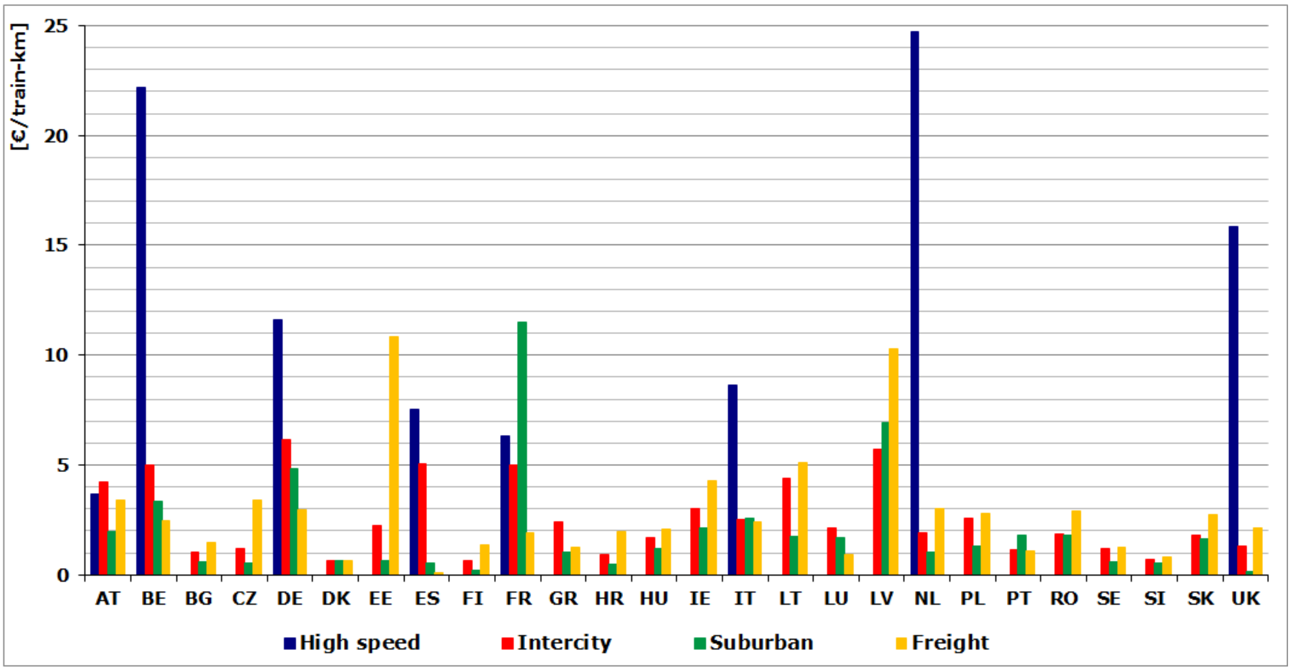
54 Council Directive of 29 July 1991 on the development of the Community's railways (91/440 /EEC).
55 Directive 2012/34/EU of the European Parliament and of the Council of 21 November 2012 establishing a single European railway area (recast).
56 Member States shall ensure that railway undertakings, directly or indirectly publicly owned, have independent status, as regards management, administration and internal control (over administrative, economic and accounting matters).
57 Commission Implementing Regulation (EU) 2015/909 of 12 June 2015 on the modalities for the calculation of the cost that is directly incurred as a result of operating the train service.
58 According to Article 32.3 on exceptions to charging principles, it can be done if the investments increase efficiency or cost-effectiveness or both and could not otherwise be or have been undertaken.
59 Cost drivers to calculate the access charges depend on cost categories to be recovered (i.e. enhancement, renewal, maintenance and operation) and are determined by trains weight (i.e. t-km) or activities performed (i.e. train-km).
60 The average cost is obtained dividing the total infrastructure costs (investment, operating and maintenance) by the intensity of usage of the infrastructure (i.e. total train-km).

At the national level, it is worth noting the approach taken by Italy, which adopted a new framework for the calculation of access charges in 2018[61]. According to the decision of the Italian regulator (Autorità di Regolazione dei Trasporti, 2015), the total access charge can incorporate incentivising components for: (i) scarcity of network capacity[62]; (ii) noise externalities; (iii) use of lines equipped with ETCS; and (iv) regional compensation regimes.

As far as external costs are concerned, they are only taken into account in calculations of access charges in other two countries. In Sweden, an emission charge is levied on diesel-engine locomotives and multiple-unit trains (Trafikwerket, 2017)[63], while in Germany, a noise charge has been levied on freight trains since 2013 (DB, 2018).

Differences also exist concerning: (i) mark-ups and market segmentation that are not applied in all Member States (and, if applied, they differ across countries); and (ii) the frequency at which the access charges are reviewed. For example, in the UK and Hungary, access charges are reviewed over relatively long periods (i.e. every five years), while in France, Italy and Poland, this is done on an annual basis. Figure 23 below presents the access charges in the Member States, differentiated with respect to four train categories (i.e. high speed, intercity, suburban and freight).

Figure 23: Rail access charges in the Member States [€/train-km]



Source: Authors' own elaboration based on Network Statements of various countries, European Commission (2016i)

With the exception of Austria[64], access charges are higher for high speed rail services than for conventional services, particularly in Belgium, the Netherlands and the UK, where investment cost recovery policies may have resulted in high mark-ups. In Italy, the access charges have been reduced by the infrastructure

61 The access charge is calculated summing up three cost components, namely train mass, path speed and wear of the contact wire (RFI, 2018). Mark-ups are related to service's market segment.

62 The scarcity costs can be compared to reservation charges applied in the Netherlands and France. In the Netherlands, a reservation charge is applied in case of cancellation and is aimed at preventing the reservation of excess capacity in the timetable (ProRail, 2018b). The reservation charge for unused capacity has the purpose of encouraging the efficient use of capacity. This charge is levied on undertakings to whom a train path is allocated and if they regularly fail to use the allocated paths or parts thereof. High reservation charges on congested routes are applied in France, both in the Ile de France and on high speed routes such as Paris-Lyon (SNCF, 2018).

63 Please see Annex 6A on train path and passage charges.

64 Applied to the international west link (i.e. Wien-Salzburg).

managers by 30% during 2015 to foster competition between the two high speed operators, Trenitalia and NTV (Desmaris, 2016).

The estimates indicate that in most Member States access charges for freight trains are higher than those applied to conventional passenger trains. However, in Austria, Belgium, Germany, France, Greece, Luxembourg, Portugal and Spain, the situation is the opposite. In Denmark, Italy, Portugal and Sweden, access charges for both of these train categories are similar or equal. The freight access charges of Estonia, Latvia and Lithuania are particularly high, reflecting the higher axle-load.

The intercity charges in Belgium, Germany, Spain and France are relatively high because these include the charges for dedicated high speed lines. Suburban access charges show a large variation ranging from € 0.2 per train-km in the UK to € 11.5 per train-km in France. This variation can be explained by different approaches at the national level to Public Service Obligation contracts.

3.2.3. Aviation

Two main categories of access charges can be distinguished in aviation. First, there are charges that relate directly to the airport infrastructure, which airlines pay to use the facilities on both the air-side (e.g. runway) and the land-side (e.g. terminal) of the airport. Second, there are charges that are not related to accessing infrastructure and which are paid both by airlines and passengers for the provision of other services.

The charges relating to the access to the airport's infrastructure depend on the airport's tariff structure and are generally calculated using one of two methods. The first method relates to the type or weight of an aircraft (i.e. it is movement-based), while the second depends on the number of passengers carried (i.e. it is passenger-based). Table 10 presents examples of the different types of charge in the different categories.

Table 10: Examples of charges in the main categories of aviation charges

Infrastructure-related		Other charges
Movement-based	**Passenger-based**	
• Landing and take-off • Aircraft parking • Noise and emissions • Infrastructure	• Passengers processing (i.e. check-in and boarding) • Passengers security charge • Persons with reduced mobility (i.e. PRM)[65] • Infrastructure	• Government levied taxes • Navigation aid (i.e. en-route and terminal[66]) • State levied security • Cargo processing • Baggage • Ground handling

Source: Elaboration of the authors based on Steer Davies Gleave (2013) and Steer Davies Gleave (2017)

The EU legislation in this area, Directive 2009/12/EC[67] (European Commission, 2009), does not specify a common framework at the EU level for infrastructure access charges. Each Member State can set its own framework for the economic regulation of the airports, including the application of single/dual/hybrid till pricing mechanisms (e.g. "price-cap", "rate of return", etc.). Such flexibility results in considerable variation in the way in which infrastructure access charges are applied at EU airports. This also means that it is not

[65] Regulation (EC) No 1107/2006 (European Commission, 2006g) establishes rules for the protection of, and provision of assistance to disabled persons and persons with reduced mobility (PRM) travelling by air, both to protect them against discrimination and to ensure that they receive assistance. Assistance to PMR is free of charge and the Regulation requires assistance to be financed in such a way to spread the burden equitably among all passengers using an airport, establishing a specific charge. On the average, the proportion of PMR charge is in the interval 1.5%-2.3% (Steer Davies Gleave, 2017).

[66] En-route charge refers to other air navigation services provided between a flight's origin and destination. Terminal charge refers to air navigation services provided to an aircraft in the vicinity of an airport before landing or after take-off.

[67] Directive 2009/12/EC of the European Parliament and of the Council of 11 March 2009 on airport charges.

possible to compare the approach taken in different airports on the basis of the published information on the structure of the charges.

Basically, unit charges relating to infrastructure access depend on the aircraft's size, the passenger mix (i.e. originated, arrived or in transit) and other ancillary services available (Steer Davies Gleave, 2017). In this respect, it is worth observing that access charges can be modulated by: (i) commercial agreements incentivising airlines to deliver higher volumes of passengers; and (ii) market competition, regulatory measures and capital and operating expenditures.

In general, the following approaches are used for movement-based cost components. The runway charge depends on an aircraft's take-off and landing operations. It is calculated according to an aircraft's classification number (ACN), which is influenced by: its maximum take-off weight (MTOW); its landing gear configuration; the location of its centre of gravity; and the runway pavement type. The runway cost corresponds to the wear and tear of an aircraft on the runway and is estimated as the marginal cost per landing.

Passenger charges are usually levied with some variation between point-to-point and transfer passengers that relates to the extent to which the passengers use the airport's facilities. This variation is differentiated also with respect to the route flown (i.e. domestic, Schengen, non-Schengen and international) to allocate the cost of immigration and security services[68].

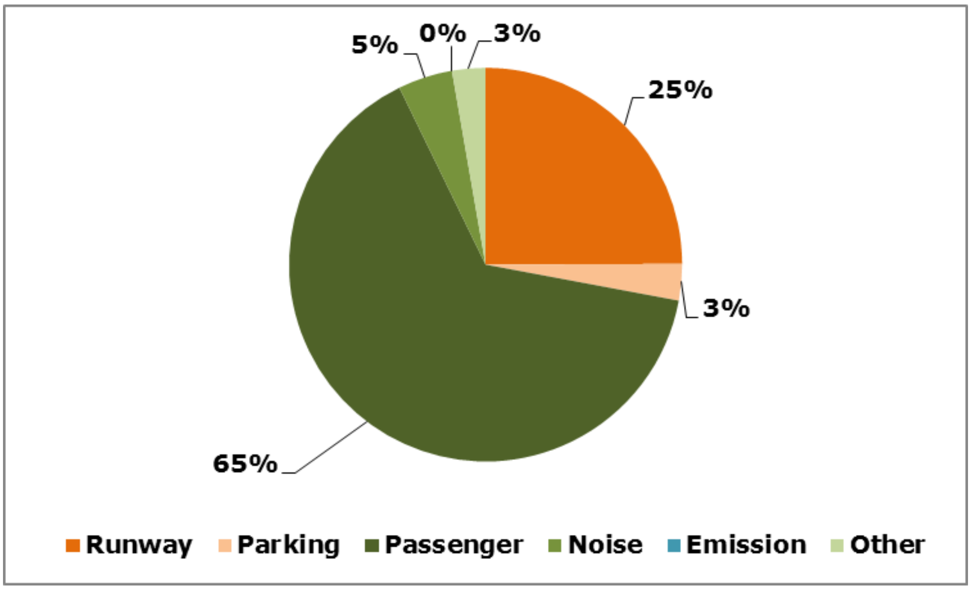
Noise and emission charges are very complex and calculating them requires detailed operational and technical knowledge. Noise charges are based on an aircraft's noise category, although their application again varies greatly between airports (ICAO, 2008). Noise charges may be applied to landing, take-offs or both movements, but some airports include noise charges in landing charges, while others define landing charge noise multipliers, while some set fixed charges by category (all of which may vary by the time of day and season). Emission charges are mostly calculated on an engine's certification and the charge is based on the emissions of nitrogen oxide equivalent (NO_x) and hydrocarbons (HC) during landing and take-off operations.

Access charges also include infrastructure charges used for pre-financing new investments. In this respect, specific rules have been created at the national level after the transposition of Article 8 of Directive 2009/12/EC.

According to estimates in Steer Davies Gleave (2013), on average for European airports, passenger charges are dominant (at 65%), followed by runway charges (25%) (please see Figure 24 below).

68 While it is straightforward to recognise the different levels of service provided for, say, Schengen and international travellers, it is not as clear what the differences might be between the services provided to domestic and Schengen passengers.

Figure 24: Average distribution of aviation charges for European airports



Source: Authors' own elaboration based on SDG (2013)

It is worth observing that charges are paid to access the network of air routes, which is non-physical, but necessary for providing air transport services. In this respect, a common scheme was introduced by Regulation (EC) No 1794/2006[69](European Commission, 2006h) and Regulation (EU) No 691/2010[70] (European Commission, 2010b). The general framework allows charges to be set on the basis of a full cost recovery approach, meaning that air navigation providers are allowed to charge the full costs to the airlines. Both regulations have been replaced by Regulation (EU) No 390/2013[71] (European Commission, 2013c) and Regulation (EU) No 391/2013[72] (European Commission, 2013d). In line with their provisions concerning "user pays" and "polluter pays" principles, Member States are allowed to modulate the charges in order to: (i) improve airlines performance by incentivising access at different times of the day to reduce air traffic congestion; and (ii) reduce environmental impact (Steer Davies Gleave, 2015; Piers et al., 2017)[73].

3.2.4. Maritime

For maritime transport, most port authorities use a public tariff for port dues and for passenger and nautical-technical service charges. Port dues are the actual access charge for the use of the port infrastructure. Passengers and nautical-technical charges (i.e. applied for pilotage, towage, mooring, handling, etc.) are charges paid for services related to vessel operations.

According to estimates from PWC and Panteia (2013), on average, port dues account for 15.2% of the total maritime charges paid at EU ports. Of the charges paid for services, handling accounts for the majority of the cost (i.e. 71.4%), followed by pilotage, towage and mooring. Charges vary with respect to the type of vessel, as far as port dues and handling costs[74] are concerned, but there is not a great variability for pilotage, towing, mooring and other services[75].

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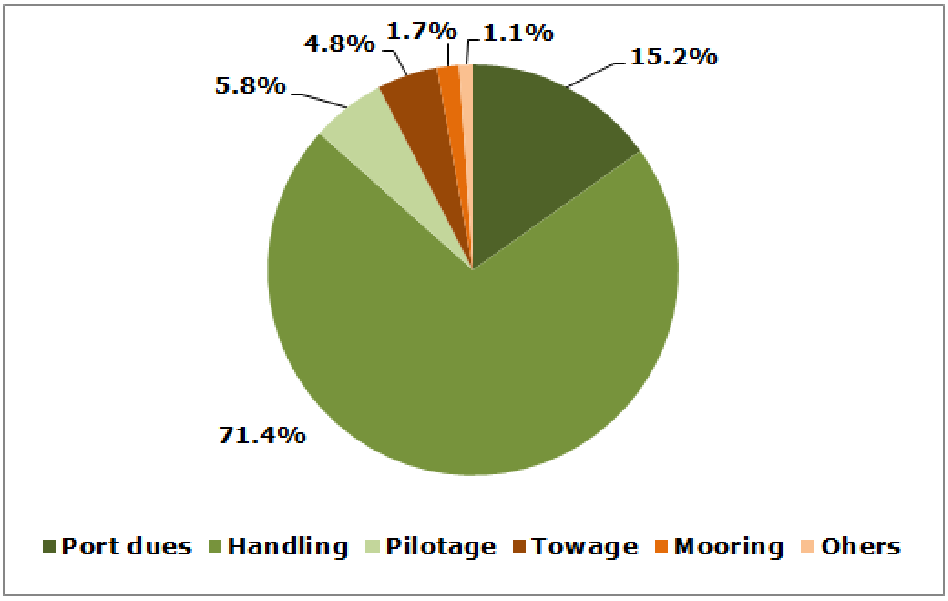
69 Commission Regulation (EC) No 1794/2006 of 6 December 2006 laying down a common charging scheme for air navigation services.
70 Commission Regulation (EU) No 691/2010 of 29 July 2010 laying down a performance scheme for air navigation services and network functions and amending Regulation (EC) No 2096/2005 laying down common requirements for the provision of air navigation services.
71 Council Regulation (EU) No 390/2014 of 14 April 2014 establishing the "Europe for Citizens" programme for the period 2014-2020.
72 Commission implementing Regulation (EU) No 391/2013 of 3 May 2013 laying down a common charging scheme for air navigation services.
73 The Eurocontrol Member States have adopted the basic principles for a harmonised regional en-route charges system involving each single flight. The Central Route Charges Office (CRCO) collects route charges that fund air navigation facilities and services.
74 It depends on the type of equipment and complexity of operations to load or unload a vessel.
75 For example, environmental services to treat waste water.

Figure 25 below presents the average share of port charges for dues and services. Subsequently, Table 11 presents the breakdown with respect to the type of vessel.

Figure 25: Average distribution of maritime charges at EU ports



Source: Elaboration of the authors based on data from PWC and Panteia (2013)

Table 11: Maritime charges per type of vessel [€/tonne]

Type of vessel	Port dues	Handling	Pilotage	Towage	Mooring	Ohers	Total
Container	0.70	7.00	0.30	0.30	0.10	0.05	**8.45**
Dry Bulk	0.60	2.00	0.25	0.25	0.10	0.05	**3.25**
Liquid Bulk	0.75	2.00	0.30	0.25	0.10	0.05	**3.45**
Ro-Ro	0.85	0.50	0.00	0.00	0.00	0.05	**1.40**
Other	0.60	5.00	0.50	0.30	0.10	0.05	**6.55**
Average	*0.70*	*3.30*	*0.27*	*0.22*	*0.08*	*0.05*	***4.62***
Share	*15.2%*	*71.4%*	*5.8%*	*4.8%*	*1.7%*	*1.1%*	***100.0%***

Source: Elaboration of the authors based on data from PWC and Panteia (2013)

The port industry authorities adopt various approaches to the application of maritime access charges. They may also apply discounts, penalties, exemptions (e.g. for frequency and environmental bonuses or penalties) and promotions on a commercial basis to attract new shipping lines. Space constraints, safety and environmental considerations[76], as well as the way in which technical-nautical services are regulated, subsidised, or not liberalised, at the national level all also influence such variability.

Amongst the multitude of possible variables, it is also worth remarking that although most port authorities are responsible for investment planning and personnel management, they do not always have full autonomy to set the tariffs applied, which can be defined by national or local governments, according to economic or social criteria based on the territory where the port operates.

Concerning maritime access charges, possible measures to tackle adverse environmental impacts of maritime operations have been considered and environmental charging has been receiving an increasing amount of attention (COGEA et al., 2017).

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[76] Marine and nautical services require a high degree of professionalism and contribute to the safety and ease of navigation in the port.

After a series of legislative actions, the 2013 European Commission Communication on ports policy (European Commission, 2013e) acknowledged the need to introduce environmental charges to abate NO_x, SO_x, PM and CO_2 emissions during port operations, as a priority of EU Transport Policy[77]. Likewise, the International Maritime Organization (IMO) has adopted a wide range of measures to prevent and control pollution caused by ships and to mitigate the effects of any damage that may occur as a result of maritime operations.

Environmental charges are generally applied as a reduction of port dues. According to estimates in COGEA et al. (2017), ports were found to reduce these dues between 0.5-20.0% and then applied them to vessels participating in environmental certification programmes[78]. Ports may also apply other specific reductions to certain categories of ships, such as vessels using liquefied natural gas (LNG).

The size of the port is not a key driver for the application of environmental charges, because the schemes implemented are relatively similar. However, small and medium ports tend to dedicate fewer resources to the set-up and follow-up of environmental charges, due to their smaller financial bases.

Short-sea shipping often faces lower charges than deep-sea shipping. For example, some ports charge short-sea shipping less if it is a core traffic segment and vessels call at the port frequently. Although such rebates are not fully driven by environmental concerns, incentives to short-sea shipping may be considered as a way of shifting traffic from roads to the sea.

3.2.5. Inland waterways

Only a limited part of the traffic transported by river or canal faces access charges. As a general rule, the level of the charges applied is low and only covers a small proportion of the total expenditure on the infrastructure. To some extent, this also depends on prudent attitudes of national authorities regarding charging policies.

In some cases, access charges are applied. For freight vessels, the tariff depends on the distance travelled and the type and volume of the cargo. For passenger vessels, the tariff relates either to the actual number of passengers on board, or to the maximum capacity. Empty vessels in most cases are exempt from charges. No charges have been identified for either the passage through moveable bridges, or for the use of the facilities of Rivers Information Systems (RIS) that are provided free of charge by public services at the national level.

The application of access charges for inland waterways is concentrated in a few countries, as presented in Box 10 below.

Box 10: Access charges for inland waterways

In **Belgium,** charges are applied on certain canals in Flanders only. Information on the revenues and costs for the operation, maintenance and repairs is not available.

In **France,** the network of navigable waterways extends for 6 700 km. According to the 2015 figures, 7.8 billion t-km have been carried by this mode of transport. On average, the tariff is equal to € 0.001 per t-km and is used for maintenance of the waterways (e.g. dredging, repair works, environmental protection and safety). The revenues earned from the charges levied cover only a small share of total costs of infrastructure maintenance (i.e. around 5.3%) (2015).

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[77] Part of this attention originates from the reaction to the EU policy developments of the late '90s, and culminated with the publication of the Green Paper on Sea Ports and Maritime Infrastructure.

[78] Initiatives like "Environmental Ship Index", "Green Award", "Clean Shipping Index" and "Blue Angel" assign scores to ships that comply with certain environmental standards.

Charges are applied for navigation on **German** inland waterways (which is 6 500 km long and which transports 220 million tonnes a year). The charges cover expenditures for civil works, including the maintenance of the waterways. Annual revenues are around € 55 million, which implies an average charge of around € 0.002 per t-km. Precise information on expenditure is not available, but expenses for maintenance, repair and investment are estimated at around € 660 million (2015). This indicates that the charges cover around 8.3% of the costs.

The Netherlands has the densest inland waterway network in Europe (i.e. 3 500 km in length, which transported 350 million tonnes in 2015); generally, users face no access charges. The average annual expenditure for maintenance, repair and investment is around € 900 million. An exception is the Mosel River, for which a charging scheme exists to reimburse the cost of canalisation works undertaken in the 1960s to improve navigability for cargo vessels (such as those used for transporting steel and agricultural products). The tariff charged is in the range of € 0.001-0.006 per t-km, but exemptions exist for many cases, which suggest that the average tariff charged is lower.

For international waterways, such as the Danube and Rhine Rivers, a specific regime exists according to Article 3 of the Revised Rhine shipping convention of 1886 (i.e. the "Mannheim Convention"), which states that "*No duty based solely on navigation may be levied on vessels or their cargoes (…) navigating on the Rhine or its tributaries (…)*".

3.3. Electronic information in transport

3.3.1. Multimodal information, management and payment system (MIMP)

Door-to-door mobility management is experiencing a fast growth in terms of actual movements and also has still a lot of potential. By incorporating real-time and personalised information, on-line services enable multimodal mobility to be accessible, transparent and available to every user, particularly via smartphones. Multimodal mobility allows users to travel using interchange facilities and different modes of transport and allows them to plan their journey properly and efficiently. The potential societal, environmental and economic benefits of multimodal mobility resulting from improved travel information and planning services as well as ticketing services are enormous. The Commission identified digitalisation, the take-up of new technologies and the widespread use and diffusion of 'big data' as paving the way for the entry into the market of new services and business models in the transport sector.

According to the 2011 White Paper on transport, one of the goals that needs to be met to achieve a competitive and resource efficient transport system was the establishment of the framework for a European multimodal transport information, management and payment system (MIMP) by 2020 (European Commission, 2011b). The MIMP is a type of Intelligent Transport System (ITS) that brings together all of the ITS technologies needed for managing the transportation system by providing information, management and payments via an integrated framework. The establishment of a common European MIMP system would potentially ensure the efficient use of all transport modes, taking account of mode-specific features. Hence, the modal choice for end users would be optimised (Rupprecht Consult, 2013).

Following the 2011 White Paper on transport, the European Commission co-financed the TRANSFORuM project, under the 7th Framework Programme, which had amongst its main focuses the development of the MIMP. The project concluded with a final roadmap for the implementation of the MIMP, proposing steps and policy measures towards the creation of a European MIMP framework.

As experienced in the TRANSFORuM project, MIMP is a complex topic involving many stakeholders, processes and services. The more the systems are integrated, the more the complexity increases. At the simplest level, the MIMP involves static timetable information, while building a pre-trip booking and payment system constitutes the most complex level within the MIMP system (Rupprecht Consult, 2013). The widespread scope of MIMP is reflected by the multiple parallel policy initiatives addressing this topic. These include, among others, the European Commission's Intelligent Transport Systems (ITS) Directive and the ITS Action Plan (European Commission, 2014a). The Commission has also published a Staff Working Document (SWD) "Towards a roadmap for delivering EU-wide multimodal travel information, planning and ticketing services", where it highlighted the fragmented landscape of ITS across the EU and the need to create an integrated system crossing the national borders.

There are many examples of the type of application that would contribute to the development of the MIMP that have been implemented across the EU. The case studies and the best practices concerning multimodal information systems, multimodal management systems and multimodal payment and ticketing systems show that these systems are mostly implemented separately and have different scopes. In other words, no horizontal harmonisation between these systems has been applied extensively and integrated systems are still lacking.

As an example of a multimodal information and management system, Rejseplanen, the biggest public transport journey planning service in Denmark, provides travellers with complete up-to-date travel information across all public transport modes, walking and cycling. It also offers door-to-door journey planning and sells tickets. Similarly, the traffic information Austria (VAO) offers a country-wide, inter-transport routing information service including all inland means of travel and highlights existing travel alternatives.

Integrated systems cannot omit consideration of the purchasing of the travel ticket. Multimodal payment and ticketing system have been widely introduced across the EU, especially in urban areas. Many different technologies are currently used – from printed paper tickets and smart cards, to tickets on mobile phones and radio-frequency identification (RFID)/Near-field communication (NFC). In this regard, travel cards have been widely adopted by local administrations. Success stories include the well-established "Oyster Card" supported by Transport for London, which can be used across most modes. The use of travel cards has led to less need for the use of cash and have enabled simplified fare structures.

Following this, with the advent of smartphones, many transport service providers, have developed ticketing and payment systems which are directly connected to electronic devices. In this regard, the German railway operator, Deutsche Bahn, installed "Touchpoints" in long distance railway stations that use NFC, 2D barcodes and readable technologies for smartphones, to allow customers to start and finish their journey.

Trenitalia, one of the major Italian railway service operators, together with the "Freccialink" service, introduced a system bringing the management and payment systems closer to being integrated. "'Freccialink'" provides a multimodal transport service including train and bus services to enable people to reach destinations that cannot be reached by trains running on the Italian railway network.

However, the framework remains fragmented across the EU. More than a hundred multimodal journey planners are, in fact, already available in EU Member States, regions and cities. Many of these were developed as part of EU-funded research projects, while others were provided by different transport operators, start-ups or public private partnerships.

In this respect, the concept of 'as-a-Service' (aaS) applied to New Mobility Services (NMSs) is taking off. AaS refers to the ability to provide users with access to services on demand on the internet, instead of having to use them at specific locations. In this context, the 'Mobility-as-a-Service' (MaaS) concept is shaping many projects following the philosophy introduced by the MIMP system, i.e. integrating different transport-related systems that are now running individually. MaaS represents the integration of various forms of transport services into a single mobility service accessible on demand. Through the MaaS model, alternative routes, transport modes and payment methods are merged into a single service platform taking information from different providers and giving access to mobility within a single channel. MaaS might be seen has a naturally-developed branch of the MIMP vision.

In 2016, the city of Hannover launched the world's first example of MaaS called the "Mobility Shop". The "Mobility Shop" service is run by Üstra (Germany) and offers users the possibility to book journeys tailored directly to their individual needs, whether it is a public transport ticket or a taxi ride with mobility options, including travel times, all of which appear in real time. All services are then invoiced via a "joint mobility bill". The concept expressed by the "Mobility Shop" service embraces the idea of multimodal information, management and payment envisioned by the MIMP concept.

Currently, many projects are investigating the concept of MaaS. The EU Research and Innovation programme Horizon 2020 has co-financed some relevant projects in this field, such as MaaS4EU, IMOVE and MyCorridor, all of them examining the emerging trend towards more integrated mobility systems. More precisely, the main objective of the EU-funded project IMOVE is to accelerate the deployment and unlock the scalability of MaaS schemes in Europe, by investigating innovative business and technology enablers at the same time. Similarly, the MaaS4EU and MyCorridor projects are planning to develop innovative ITS platforms to combine connected traffic management and multi modal services.

As already stated, this field is quite fragmented, and although studies are ongoing, at present there are no established frameworks and quantifiable evidence about the costs and benefits of NMSs. In order to facilitate a modal shift through the adoption of smarter public transport solutions and services, it is necessary to rebalance the way in which transport systems are operating to create more favourable playing fields between the different modes of transport.

3.3.2. Digital framework for electronic information exchange

The explosion of international trade in the 20th century around the world resulted in increased complexity of regulation. Traditionally, before the last deregulation process in early 1980s, trade was regulated through bilateral treaties between countries, which ensured that their interests were protected through the application of import/export tariffs. Then, the advantages of free trade became evident, especially to the growing economies in the south-east Asia. In order to promote free trade and create a globally regulated trade structure, the World Trade Organization (WTO) was established in 1995 (WTO, 1995). During recent decades, transport authorities have introduced an extensive range of agency-specific and national-specific regulatory requirements for international trade. Coordination between agencies at the national, EU and international levels has also been introduced to ease the processes. However, a number of obstacles, including the insufficient standardisation of the respective information exchanges and the extensive range of regulations in freight logistics, need to be further addressed and overcome.

A cross-border shipment may typically involve around 35 document exchanges between more than 25 parties and there is something like 600 laws and almost the same number of trade agreements to be considered depending on the countries and agencies involved around the world (E-Freight project, 2011). Hence, transport operators face a very complex system of cumbersome reporting requirements, with different forms, data, messages, IT systems and so forth. As a result, international trade has a very disconnected logistics chain, causing low levels of efficiency, increased costs and above all longer shipping times. The requirement for a large amount of documentation for moving goods has been extensively discussed in recent decades and is considered to be a serious barrier to the development of international trade.

Back in 2005, the United Nation Centre for Trade Facilitation and Electronic Business (UN/CEFACT) introduced the concept of a Single Window (SW) in an attempt to ease the reporting burden on both governments and the business community involved in international trade. The approach consisted of the establishment of a SW, whereby trade-related documents are submitted once through a single-entry point, making available the necessary information to all stakeholders involved in cross-border trade in the same way at the same time.

The following definition was introduced to describe this new concept: "**A Single Window is defined as a facility that allows parties involved in trade and transport to lodge standardised information and documents with a single entry point to fulfil all import, export, and transit related-related regulatory requirements**" (UN/CEFACT, 2015).

The SW concept started to take shape at the EU level through Decision No 70/2008/EC[79], which aimed to facilitate data exchange between stakeholders trading within the EU. In particular, it puts responsibility on the Member States to ensure the promotion and implementation of electronic customs services and SW services at the national level.

The concept was developed in the Freight Transport Logistics Action Plan as one of the key policy initiatives jointly launched by the Commission to improve the efficiency and sustainability of freight transport in the EU (Action 2.2, European Commission 2007c). In particular, the Plan envisaged the establishment of a SW (single access point) and one-stop- shop for administrative procedures for all modes across the EU. Furthermore, the Action Plan envisioned the introduction of E-freight and ITS technologies to support co-modality (the use of different modes on their own and in combination) and thus improve infrastructure, traffic and fleet management, facilitate a better tracking and tracing of goods across the transport networks and to better connect businesses and administrations (Action 2.1, European Commission 2007c).

Following the Freight Transport Logistics Action Plan, the Commission co-funded several research, technological development and demonstration projects through the 7th Framework Programme. One of the key projects in this field was the E-FREIGHT project[80]. The ambition of the E-FREIGHT project was to:

- support EU freight transport stakeholders to implement a common, standard framework for freight trade within the European Community, through IT solutions; and
- facilitate the combined use of different transport modes, for an optimal and sustainable utilisation of European freight transport resources.

Based on IT solutions, the E-FREIGHT project aimed to demonstrate that paperless information exchange, amongst all EU freight transport stakeholders in the European Community and, as far as possible, internationally, was possible in practice. The E-FREIGHT's concept for Next Generation National SW consisted of a multimodal national SW deployed in each Member State and centrally supported by the EU. Fundamentally, the project aimed at overcoming the missing link between different national SWs and the introduction of a multimodal SW at the EU level.

[79] Decision No 70/2008/EC of the European Parliament and of the Council of 15 January 2008 on a paperless environment for customs and trade.

[80] European e-freight capabilities for co-modal transport (Acronym "E-FREIGHT"). The project has been financed under the seventh Framework Programme, carried out from January 2010 to June 2013.

Currently, the implementation of SWs at the EU level mainly concerns maritime transport, as required by Directive 2010/65/EU[81], which came into force in 2015. The objective of this Directive was to "simplify and harmonise the administrative procedures applied to maritime transport by making the electronic transmission of information standard by rationalising reporting formalities". The execution of this action was delegated to the European Maritime Safety Agency (EMSA), and was carried out through a demonstration project which consisted of setting up a prototype of a National SW (NSW prototype) in six "pilot" countries (EU Member States, Bulgaria, Greece, Italy, Malta and Romania, as well as non-EU Member State Norway). The development of the prototype demonstrated the potential benefits related to the reduction of administrative procedures through simplified and harmonised electronic reporting for the maritime sector, enabling a smooth and fast flow of data. The main identified benefits for the shipping industry and freight transport-related authorities included:

- easier and faster sharing of information between the stakeholders involved;
- re-use of information submitted in previous calls;
- easy-to-view decisions from authorities thanks to the earlier receipt of reporting formalities;
- ability to communicate with ship data providers, including information regarding clearance decisions; and
- the consolidation of information provided by different data providers for a single port call.

One of the actions supported by the Commission, which constituted the basis for the development of an EU SW started in 2013 with the publication of the Communication on the Blue Belt, a single transport area for shipping[82]. This Communication indicated that a harmonised and electronic cargo manifest (the so-called eManifest), providing information on the status of goods, should be considered as the comprehensive practical solution towards the further establishment of a true single market for maritime transport.

Following the Blue Belt initiative, the idea of a harmonised and electronic manifest has received widespread support. In 2016, the European Commission Directorates for Mobility and Transport (DG MOVE) and Taxation and Customs Union (DG TAXUD) agreed to launch – together with EMSA – the most comprehensive pilot project in this field, to demonstrate how the eManifest could be reported by electronic means via the European Maritime Single Window prototype (EMSW). The overall objective of the pilot project is to simplify the submission of data elements required by both maritime and customs authorities, using a common set of cargo data. The project group included the custom authorities of 13 Member States with the technical support provided by the EMSA.

3.4. Progress made in urban areas: integration of local, regional and international traffic

While the goals set in the 2011 White Paper on transport are not specifically focused on the integration of the different modes, there are a range of relevant initiatives to: (i) improve integration within the mobility system; (ii) take forward measures for seamless door-to-door mobility; (iii) promote more sustainable behaviour; and (iv) improve integration within urban mobility, in particular.

[81] Directive 2010/65/EU of the European Parliament and of the Council of 20 October 2010 on reporting formalities for ships arriving in and/or departing from ports of the Member States and repealing Directive 2002/6/EC.

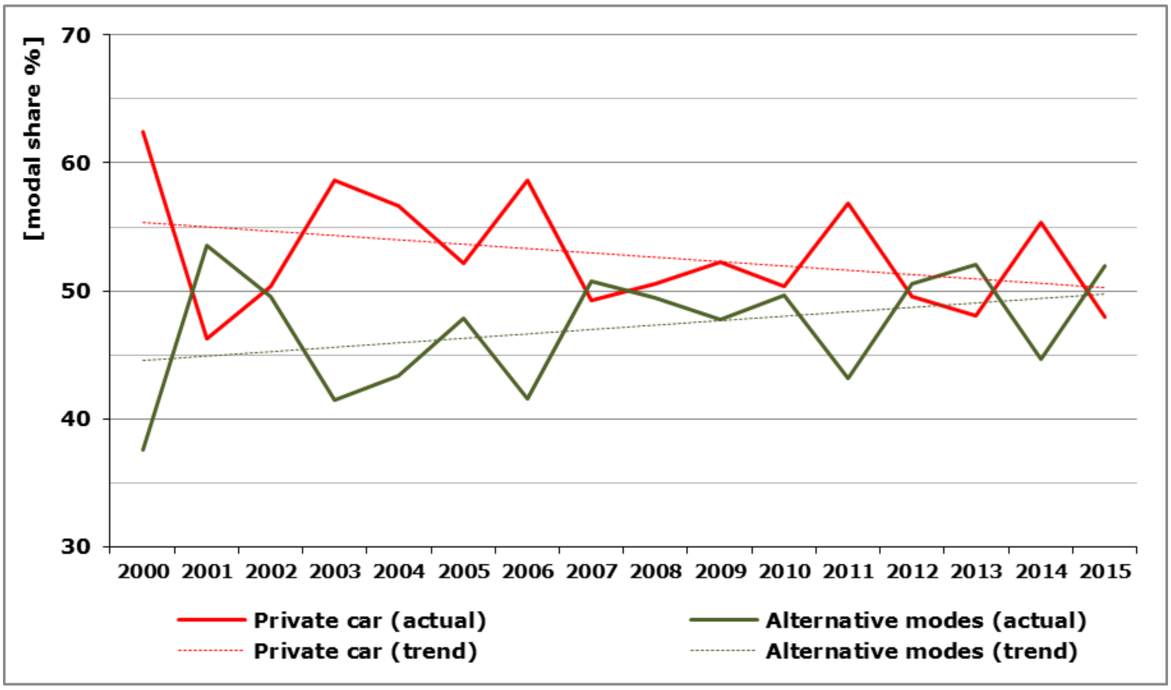
[82] Communication from the Commission, Blue Belt, a Single Transport Area for shipping, Brussels, 8.7.2013 COM(2013) 510 final. The Communication was issued in response to the requirements of the Single Market Act II - Together for new growth, published in October 2012.

Urban areas are the origin and destination of many passenger and freight journeys and are where transport demand tends to concentrate. As they are the origin and destination of local, regional and international transport, **integration between these types of journeys can be delivered in urban areas** where all of these types of journey occur to some extent.

According to the United Nations[83] data, the share of the population living in EU cities has increased from 50% in 1950 to 74% in 2015[84]; urban areas are also where 85% of the total GDP is generated. The increase in population has had a significant impact on urban mobility, as the need to make the most efficient use of the limited urban space has become increasingly important. This has underlined the importance of intermodal integration and the need to promote **sustainable travel behaviour**, i.e. travelling less by private car, and more by public transport, cycling, walking and shared cars.

Urban travel behaviour has changed through time. Data from the European Platform on Mobility Management (EPOMM), based on a sample of 485 EU cities of different population sizes, suggest that there has been a slight trend towards less use of private cars. Figure 26 below shows that the modal share for private car use has decreased from around 55% in 2000 to 50% in 2015, while there has been a corresponding increase in the use of alternative modes (i.e. walk, bike and public transport).

Figure 26: Urban modal share of private car and alternative modes



Source: Authors' own elaboration based on EPOMM data[85]

As they are normally located within urban areas, train stations are the transport nodes where different modes and journey types come together, especially if high speed rail services link the city to other countries or to an airport. Airports can be the focus of integration between different modes and journey types, depending on their location with respect to the closest major urban area. For airports that are very close to urban areas, metro stations at terminals normally provide direct and fast access. For airports farther from urban areas, train or bus stations at terminals provide dedicated feeder services to urban areas.

83 Data available on https://population.un.org/wup/Download/.
84 Projections to 2050 foresee that the share of urban population living in EU cities could increase up to 82% in 2050.
85 Please see on webpage http://www.epomm.eu/tems/compare_cities.phtml.

In principle, the **extent to which integration can be achieved depends on local characteristics**. In the literature, there is no single recipe – no silver bullet; rather integration between the modes needs to be undertaken by bringing together a range of measures (May et al., 2006; Potter, 2010).

Integration is needed on a number of different levels. First, **locational integration**, i.e. bringing together the different modes at a single location, enables users to make a seamless change between transport modes in dedicated intermodal interchanges. The way in which such intermodal interchanges are developed has become increasingly varied across the Member States[86] in order to: (i) take account of specific conditions present in the urban area; (ii) to enable a diversity of travel options; and (iii) account for differences in users' behaviour and requirements. Whereas the layout of such interchanges had previously been treated in a superficial manner, it is now acknowledged that the design is an important element of the integration between different modes (Hoogendoorn, 2015).

Second, the **integration of timetable and information provision** is important to facilitate the use of transport services for difference modes, e.g. limiting the waiting time for those transferring between different modes and communicating this clearly to users. Birgit et al. (2015) showed that transport nodes can be optimised by coordinating, not only transport services, but also improving the accessibility of information and the way in which it is displayed. This enables users to learn about type of connecting services available and where they leave from, e.g. in terms of service frequency, the location of stops and alternative services.

Third, the **integration of ticketing** between transport operators operating in the same urban areas is important, e.g. making sure that tickets are valid on all (or most) services throughout a whole region. In many urban areas, **such integration is still lacking**, as their geographical scope, and/or the services that they are valid on, are often limited (Pillath, 2015). According to Maffii et al. (2012), for long distance travel, **integration between different rail services was not good**, while **integration between air transport and rail had seen some improvements** over the last decade. For public transport, easy and smart payment methods have facilitated the diffusion of innovative card systems, which can be used for contactless payment of integrated fares[87] (CIVITAS, 2010; UIC, 2017).

To **make it easier for users to travel**, many local administrations are **introducing integrated electronic payment systems, including smart card and mobile phone apps**, which can be used to pay for various transport services[88]. For example, the "Whim" app[89] allows users to: (i) plan their route; (ii) purchase tickets for buses and trains, and (iii) pay for bike sharing, taxis and car hire.

Since 2013, urban areas have been considered to be an integral part of EU transport policy, especially in relation to the development of the TEN-T[90], as they are seen as the location where long-distance travel meets urban/peri-urban/regional transport, as well as where it is possible to switch to alternative transport modes. As a result of the increasing share of the population that live in cities and that here it is easier to use alternative modes, as discussed above, in **urban areas, there is a great potential to promote the use of the most environmentally and climate friendly transport modes and thus to contribute to smart, safe and sustainable transport**.

[86] The CIVITAS Initiative explored integrated strategies for sustainable mobility http://civitas.eu/mobility-solutions/thematics/integrated-planning.

[87] Smart payments can also provide valuable data on behaviour and mobility patterns of users.

[88] But also for attractions such as museums and recreation centres.

[89] Please see http://maas.global/our-solutions/.

[90] In total, 88 urban nodes are listed in Annex II of Regulation (EU) N° 1315/2013 (European Commission, 2013a). It is also worth noting that the most important transport nodes of the TEN-T core network (i.e. ports, airports, train stations and other terminals) and the major TEN-T urban nodes often coincide.

In line with the objectives of the TEN-T corridors and those of sustainable urban mobility, as also promoted by the Commission in the **2013 Urban Mobility Package (UMP)** (European Commission, 2013j)[91], the European Structural and Investment Funds (ESIF), allocated € 13 billion for urban mobility projects for the 2014-2020 period. This was an increase of 56% compared to the previous financing period.

The Connecting Europe Facility (CEF) calls of 2014 and 2015 included a dedicated call[92] for urban nodes of the core network to support their integration and to enhance their connections with TEN-T infrastructure (Balázs et al., 2016). In total, **22 projects have been selected** and co-funded under these CEF calls for a total amount of **around € 149 million**. In particular, the 2014 call allocated € 49 million for projects in seven urban nodes[93] and the 2015 call supported actions for € 100 million[94]. On top of that, and specifically for freight transport, 25 additional projects focusing on multimodal urban logistics platforms were support, for a total of € 93.5 million (Kissler, 2016).

In parallel to the CEF calls, the **Horizon 2020 programme** "Smart, green and integrated transport" **included a topic on "Innovative approaches for integrating urban nodes in the TEN-T core network corridors"**, which focused on a greater use of intermodal urban freight logistics and approaches to link long-distance transport with last-mile freight delivery in urban areas.

Since the adoption of the 2013 Urban Mobility Package, the Commission has also promoted the use of Sustainable Urban Mobility Plans (SUMPs), as tools for sound policy coordination in the framework of sustainable urban development (Wefering et al., 2013)[95]. **SUMPs aim to** integrate both passenger and freight mobility with the wider urban and territorial development strategy. In this view, they are a local planning instrument to **move towards a balanced development and integration of all transport modes and to encourage a shift towards the most sustainable modes**.

According to the survey conducted in Durlin et al. (2018), around **1 000 SUMPs had been adopted** in the Member States by 2017. This was a marked increase compared to the situation of 2013, when 800 SUMPs were identified. In particular, the increase in the use of SUMPs in Romania, Slovenia and Sweden contributed to this improvement.

It is also worth noting that amongst these 1 000 SUMPs, 290 are the second, or third generation SUMPs. If one considers that the survey found that the **number of SUMPs in preparation had also increased** (i.e. from 160 to 350), this suggests that those developed in the past might have played a role in disseminating knowledge of this instrument.

The **main drivers behind the development and adoption of SUMPs** are specific to the country in which the city is located, and include: (i) the availability of national funding[96]; (ii) targets that are in place to reduce environmental impacts (and thus external costs) of transport; (iii) political and public support; and (iv) the extent to which the SUMP is perceived to improve the attractiveness of a city. On the other hand, a clear relationship was not found between drivers and city type or characteristics.

[91] Please see also https://ec.europa.eu/transport/themes/urban/urban_mobility/ump_en.

[92] Specific objectives of the call were actions addressing: (i) physical bottlenecks and missing links between transport modes in the urban area; (ii) seamless connection between the TEN-T long-distance transport and the urban transport; and (iii) multi-modality, shift to more sustainable mode, shift to alternative fuels and enhance the integration of long-distance and urban transport.

[93] Birmingham, Frankfurt, London, Norrkoping, Malmo/Copenhagen, Paris and Lyon.

[94] Of which, € 50 million under the general call and € 50 million under the cohesion call, respectively.

[95] Please see also http://www.eltis.org/sites/default/files/guidelines-developing-and-implementing-a-sump_final_web_jan2014b.pdf.

[96] The development of SUMPs is not a pre-condition to access to EU funding, but they can be linked with TEN-T actions in urban nodes, especially if cities are along CNCs.

3.5. EU financing for transport multimodal projects

Multimodal transport combines, in a resource efficient manner, different modes exploiting each other's strengths and offsetting their weaknesses. The EU pursues a policy of multimodality by ensuring better integration between transport modes and by working to establish interoperability at all levels of the transport system, including by implementing infrastructure projects and measures to enhance interconnections between the single modes at links or nodes.

In general, door-to-door multimodal travel, either for passengers or freight, can be defined as a journey that combines two or more transport modes moving from an origin to a destination. Switching from one mode to another during the same journey can be perceived as a nuisance, so the aim is to make this as seamless as possible at interchanges.

A major goal of the development of modern multimodal passenger transport is to reduce users' dependence on cars and thus encourage modal shift towards a combination of alternative modes (e.g. public transport, cycling or walking). This can be achieved, for example, by providing a common information platform for travel planning, booking and integrating ticket payments, as discussed above.

On the other hand, multimodal freight transport is characterised by the use of different modes for moving goods stowed into intermodal loading units (i.e. a container, or a swap body, or semi-trailer) from the consignor to the consignee. It involves a variety of activities, actors and resources and also implies technological, as well as organisational complexity.

For both passenger and freight, technological innovations have played an important role in improving multimodal transport. As seen above, technological innovations, which bring together computer and communication technologies, have made possible access to real-time information for users. They have also improved the efficiency and organisation of the scheduling of passenger services and freight operations at multimodal nodes.

The objectives of 2011 White Paper on transport for multimodal transport focus on eliminating obstacles to a smooth functioning of and effective competition in the internal market. The goal is to achieve a single European transport area by eliminating physical and regulatory barriers between modes and systems at national level, easing the process of integration and facilitating the emergence of multinational and multimodal operators.

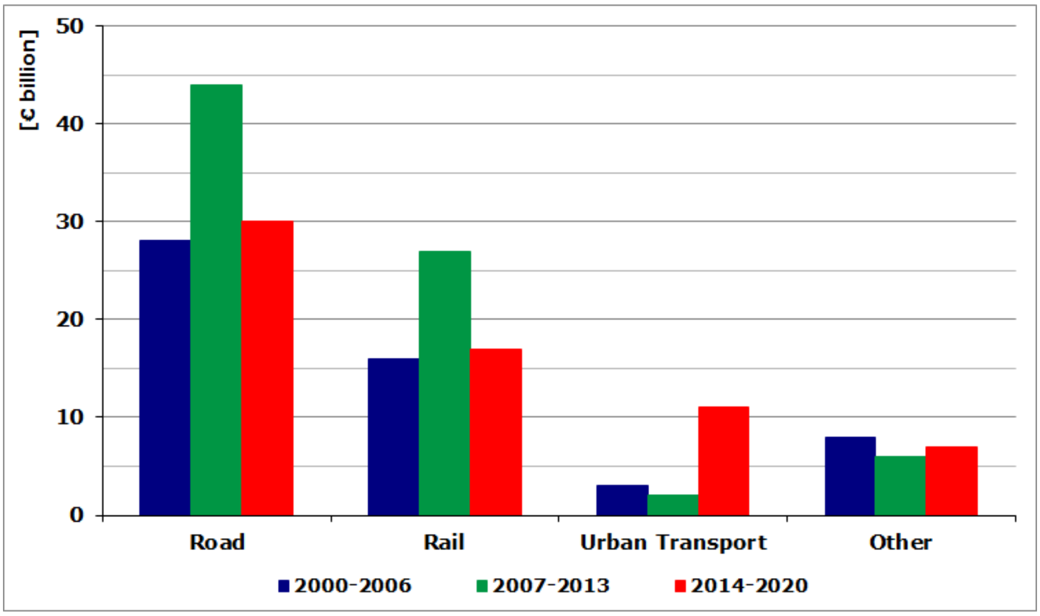
According to the 2011 White Paper on transport, the TEN-T core network should be developed to ensure efficient multimodal links, ports, airports and key land border crossings, focussing on the completion of missing links (e.g. cross-border sections, bottlenecks and bypasses). Specifically, for multimodal freight transport (i.e. E-freight), an appropriate framework for tracing goods in real time, ensuring intermodal liability and promoting clean freight transport can be put in practice through the concepts of "SW" and "one-stop-shop" by creating and deploying a single transport document in electronic form (electronic waybill). Similarly, for passengers, the 2011 White Paper on transport envisages the need to establish a legislative framework on passenger rights with measures covering passengers on multimodal journeys with integrated tickets under a single purchase contract.

To contribute to the achievement of these objectives, multimodal transport projects can be funded by a number of European funds, which basically work as catalysts around which Member States provide the majority of the resources needed.

The EU Structural and Cohesion funds covered the transport financing needs of the periods 2000-2006 (European Commission, 1999b)[97] and 2007-2013 (European Commission, 2006a)[98], respectively[99]. The ongoing 2014-2020 period introduced a new legislative framework establishing a link with the Europe 2020 Strategy (European Commission, 2010c; European Commission, 2015b). Transport projects can be financed under the European Structural and Investment Funds (ESI Funds), including the European Regional Development Fund (ERDF) (European Commission, 2013g) and the Cohesion Fund (European Commission, 2013h). In 2013, the EU introduced an enhanced financing instrument dedicated to the development of TEN infrastructure, including that for the TEN-T, through the Connecting Europe Facility (CEF) (European Commission, 2013b). Its aim is to accelerate the implementation of the transport projects on the TEN-T through grants and to a lesser extent, through blending public and private resources.

Figure 27 below presents an overview of the budget allocations of the ESI Funds (i.e. the Cohesion Fund and the ERDF) to transport projects by transport mode and with respect to the periods 2000-2006, 2007-2013 and 2014-2020.

Figure 27: EU budget allocation of ESI Funds to transport projects by mode



Source: Elaboration of the authors based on Monfort (2015)

During the period 2000-2006, the initial allocation of resources for multimodal transport projects through the ERDF was only 3.5%, so constituted a small share of the total budget, despite the wider goals identified for this specific sector in the 2001 White Paper on transport[100].

97 Council Regulation (EC) No 1260/1999 of 21 June 1999 laying down general provisions on the Structural Funds has been amended by Council Regulation (EC) No 1447/2001 of 28 June 2001 amending Regulation (EC) No 1260/1999 laying down general provisions on the Structural Funds (European Commission, 2001b) and Council Regulation (EC) No 1105/2003 of 26 May 2003 amending Regulation (EC) No 1260/1999 laying down general provisions on the Structural Funds (European Commission, 2003).

98 Please see also Commission Regulation (EC) No 1828/2006 of 8 December 2006 setting out rules for the implementation of Council Regulation (EC) No 1083/2006 laying down general provisions on the European Regional Development Fund, the European Social Fund and the Cohesion Fund and of Regulation (EC) No 1080/2006 of the European Parliament and of the Council on the European Regional Development Fund (EC, 2006b), Regulation (EC) No 1080/2006 of the European Parliament and of the Council of 5 July 2006 on the European Regional Development Fund and repealing Regulation (EC) No 1783/1999 (EC, 2006c), Regulation (EC) No 1082/2006 of the European Parliament and of the Council of 5 July 2006 on a European grouping of territorial cooperation (EGTC) (EC, 2006d), Council Regulation (EC) No 1084/2006 of 11 July 2006 establishing a Cohesion Fund and repealing Regulation (EC) No 1164/94 (EC, 2006e) and Council Regulation (EC) No 1085/2006 of 17 July 2006 establishing an Instrument for Pre-Accession Assistance (IPA) (European Commission, 2006f).

99 In parallel, also the TEN-T guidelines were revised further to take account of the 2004 and 2007 EU enlargements, which caused delays and financing problems, in particular for cross-border sections.

100 As regards the Cohesion Fund, the ex-post evaluation carried out did not address multimodal projects (AECOM and RGL Forensics, 2012). The analysis of the transport sector focusses on 99 projects for road and 112 projects for rail in order to examine the contribution of the Cohesion Fund to the development of the TEN-T network during the 2000 to 2006 period.

Table 12 summarises the overall allocation of the ERDF to multimodal projects, with respect to initial and final resources and the level of actual expenditure (Steer Davies Gleave, 2010) (please see also Table 24 in Annex E). The share of ERDF allocated to multimodal projects was relatively unchanged at the different stages of fund allocation (the initial allocation, final allocation and actual expenditure). The overall absorption rate of the ERDF, i.e. the ratio of actual expenditure to final allocation, is equal to 83.8%, which is slightly above the average of all transport modes standing at 82.4%.

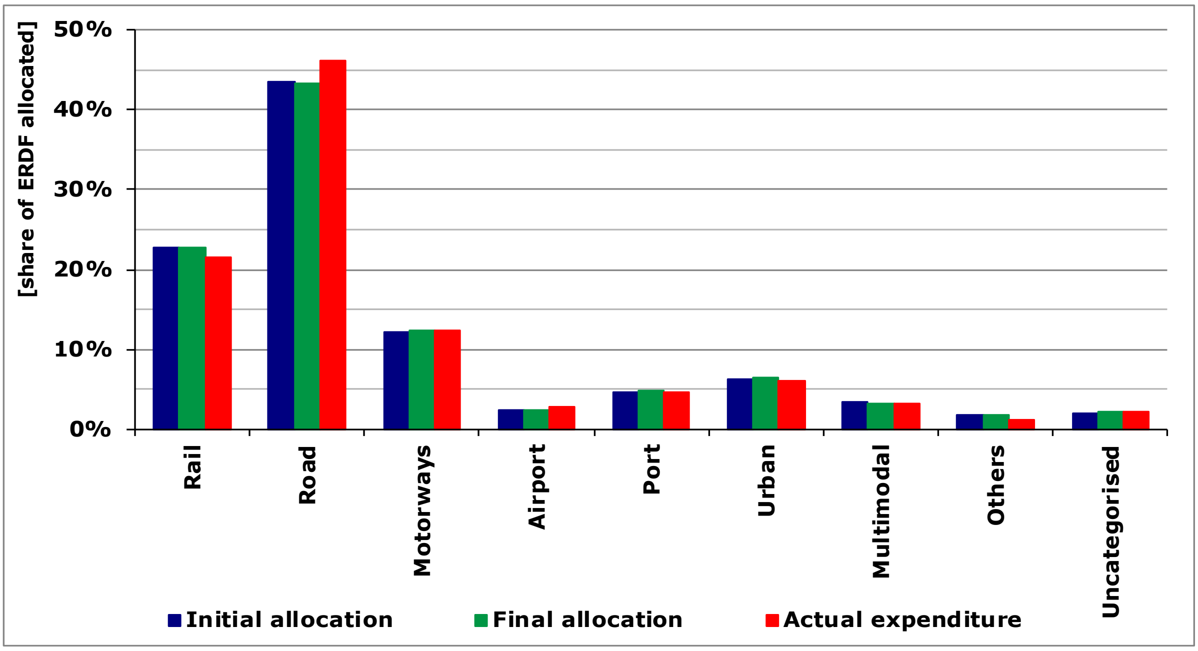
Table 12: ERDF funds allocated to multimodal projects (2000-2006) [€ million]

Project	Initial allocation	Final allocation	Actual expenditures
Multimodal	1 098	1 114	936
All modes	31 175	33 843	29 124
Multimodal share [%]	*3.52*	*3.29*	*3.21*

Source: Elaboration of the authors Steer Davies Gleave (2010)

On average, at the EU level, the share of the ERDF that Member States allocated to multimodal projects reduced from 3.5% of the initial allocation to 3.2% of actual expenditure, reflecting a shift of resources to motorways, airports, ports and urban projects (please see Figure 28).

Figure 28: Average EU share of ERDF allocated by transport modes (2000-2006)



Source: Elaboration of the authors based on Steer Davies Gleave (2010)

At the national level, the highest amount of ERDF initially allocated to multimodal projects was in Portugal (i.e. € 552.8 million), followed by Italy, France, Spain and the UK. Through the allocation categories, the funds committed in Portugal declined, while for Italy, the level of actual expenditure was higher than the initial allocation. For France, Spain and the UK, the allocations remained relatively unchanged. It is also worth observing that: (i) 13 out of the 25 countries for which data are available (i.e. 52%) did not allocate any ERDF funds to multimodal projects; and (ii) Austria initially allocated the highest share (i.e. 40%), but both final allocation and actual expenditure were significantly lower (i.e. 2%).

As regards the programming period 2007-2013, the allocation of ESI Funds for all transport modes was initially set at € 80.9 billion, which increased to € 82.3 billion at the final allocation (Finnegan and Signorile, 2016). The actual expenditure was estimated to be around € 67 billion, which makes the average absorption rate across all transport modes equal to 81.4% (please see Table 13).

Table 13: ESI Funds allocated to multimodal projects (2007-2013) [€ million]

Project	Initial allocation	Final allocation	Actual expenditures
Multimodal	2 082	1 928	1 495
All modes	80 961	82 301	67 003
Multimodal share [%]	*2.57*	*2.34*	*2.23*

Source: Elaboration of the authors based on Steer Davies Gleave (2010)

During this period, Member States channelled ESI Funds to TEN-T projects and in particular to motorways and railways, of around € 19.9 billion (i.e. 24.1%) and € 17.6 billion (i.e. 21.3%), respectively. The share was much smaller for multimodal projects and again progressively declined from 2.57% at the initial allocation to 2.23% as regards the actual expenditure. The absorption rate was equal to 77.5%, which was below the average for all transport modes standing at 81.4%.

In addition to the sources available to transport projects from the ESI Funds, within the 2007-2013 perspective, the TEN-T projects could also benefit from the TEN-T Fund, which set aside € 8 013 million for their support (European Commission, 2007c)[101]. Given the scarcity of resources recognised for that programming period, priority was given to projects with the greatest estimated added value for the EU, such as cross-border sections, and to removing bottlenecks.

According to elaborations from the Innovation and Networks Executive Agency of the European Commission (INEA), whose predecessor managed the TEN-T Fund, from the calls for proposals between 2007 to 2013, 54 multimodal projects were selected for EU co-financing out of a total of 692 projects covering all transport modes that were co-financed, which amounted to 7.8% of the total number[102]. On average, within this programming period around 25% of the estimated investment costs (i.e. € 125.3 million against € 509.4 million) was granted to multimodal projects. Table **14** presents the number of multimodal projects and co-funding grants by year.

Table 14: Co-funded TEN-T priority multimodal projects (2007-2013)

Year	Multimodal projects				All transport projects		
	Selected projects	Estimated cost [€ million]	EU financing [€ million]	EU co-funding rate	Selected projects	EU financing [€ million]	Maximum funding [€ million]
2013	8	11.2	8.9	79%	106	320.7	350.0
2012	16	151.3	28.9	19%	172	1 595.6	1 597.0
2011	10	106.4	21.5	20%	100	359.9	200.0
2010	6	108.9	18.6	17%	51	190.6	192.0
2009	3	4.2	2.1	50%	60	936.6	1 010.0
2008	4	13.3	6.6	50%	63	185.3	4 664.0
2007	7	114.1	38.7	34%	140	6 148.0	
Total	**54**	**509.4**	**125.3**	**25%**	**692**	**9 736.7**	**8 013.0**

Source: Elaboration of the authors based on INEA[103], European Commission (2016g), Finnegan and Signorile (2016)

With respect to the geographical coverage, there is an unbalanced distribution of multimodal TEN-T projects between Member States (please see Figure 29 below). This is notably in favour of the EU-15, which benefitted from the co-financing of 41 (out of 54) multimodal projects selected under TEN-T Programme.

[101] Please see Article 18 of Regulation (EC) No 680/2007. The contribution from the EIB was € 500 million.

[102] For both annual and multi annual calls. With the exception of 2011 in Table 14, which indicates only the value of maximum funding from annual call.

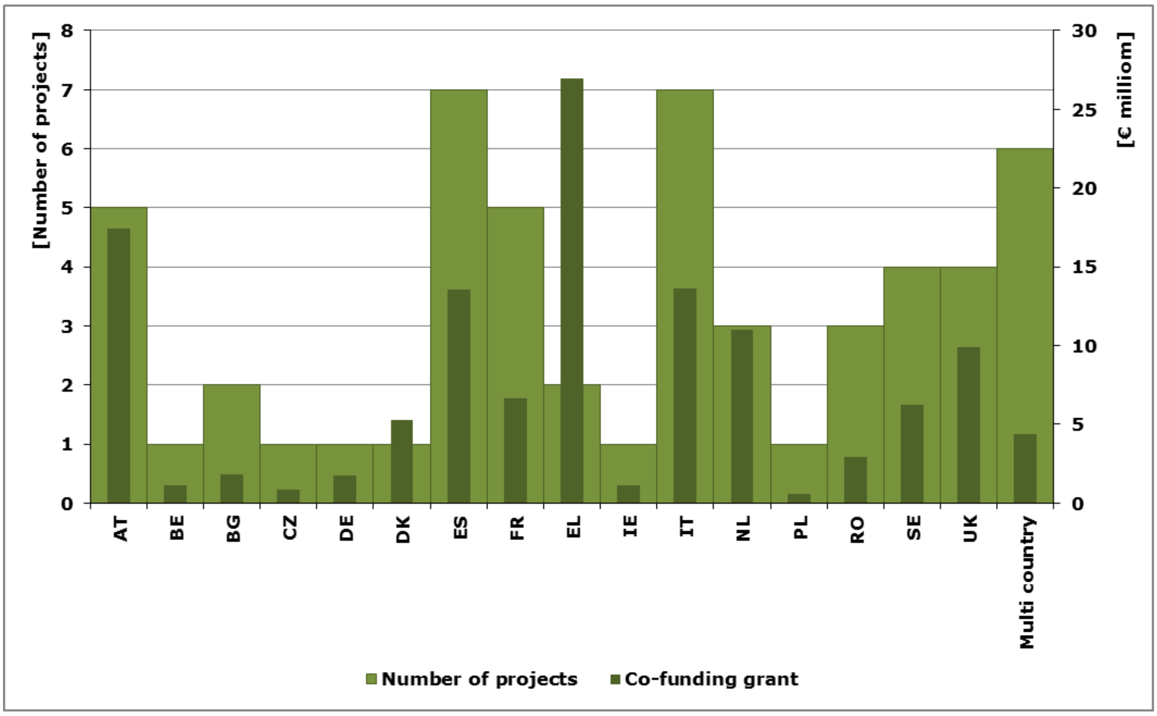
[103] https://ec.europa.eu/inea/ten-t/ten-t-projects/statistics.

Only seven of the selected projects were from the EU-12[104]. Finally, six multimodal projects involving more than one country were supported. It is worth observing that 12 countries did not benefit from any of the multi-modal projects that were selected for support.

At the national level, the highest number of multimodal projects supported by the TEN-T Fund was found in Italy and Spain (i.e. seven projects respectively, or 13% of the total in each case), while Greece received the highest share of co-funding grants (i.e. € 26.9 million or 21%). Compared to the ERDF allocation of the previous programming period, France, Italy, Spain, and the UK still received a relatively high level of the total resources (i.e. € 43.8 million), whereas Portugal did not have any project supported. As regards multi-country multimodal projects, they can be linked with measures that developed solutions in transnational transport corridors, or in preparation of macro-scale strategies financed under specific programmes, such as INTERREG III[105] (Panteia, 2010).

Figure 29 below presents the distribution of: (i) number of multimodal projects; and (ii) co-funding grants for Member States that received support for projects from the TEN-T Fund between 2007 and 2013.

Figure 29: Multimodal projects and grants to Member States submitting proposals in response to TEN-T calls (2007-2013)



Source: Elaboration of the authors based on INEA data, European Commission (2016g), Finnegan and Signorile (2016)

Regarding the ongoing 2014-2020 programming period, the policy framework set by Regulation (EU) 1303/2013[106] (European Commission, 2013i) aims to foster better cooperation and coordination between various EU funds. In the case of transport, these include primarily the ESI Funds (the Cohesion Fund and the ERDF) and the Connecting Europe Facility (CEF).

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104 In 2004, ten countries joined the European Union (i.e. the Czech Republic, Estonia, Cyprus, Latvia, Lithuania, Hungary, Malta, Poland, Slovakia and Slovenia). In 2007, they were followed by Bulgaria and Romania.

105 INTERREG is a series of programmes to stimulate cooperation between regions in the European Union, funded by the European Regional Development Fund.

106 Regulation (EU) No 1303/2013 of the European Parliament and of the Council of 17 December 2013 laying down common provisions on the European Regional Development Fund, the European Social Fund, the Cohesion Fund, the European Agricultural Fund for Rural Development and the European Maritime and Fisheries Fund and laying down general provisions on the European Regional Development Fund, the European Social Fund, the Cohesion Fund and the European Maritime and Fisheries Fund and repealing Council Regulation (EC) No 1083/2006.

The Cohesion Fund allocates a total of € 63.4 billion for: (i) development of TEN-T; and (ii) environment protection (comprising transport, if related to developing rail, supporting intermodality and strengthening public transport). Under the theme "Network Infrastructures in Transport and Energy", the Cohesion Fund supports investment priorities to promote sustainable mobility and to remove infrastructure bottlenecks with an allocation of € 32.5 billion. The ERDF allocates € 24.8 billion under the theme "Network Infrastructures in Transport and Energy". Additionally, the CEF was set up in 2013 to speed up an implementation of the TEN-T projects. It replaced the 2007-2013 TEN-T Fund with a much larger allocation of € 24.05 billion to be spent on transport projects. (This allocation included € 11.3 billion that was transferred from the Cohesion Fund to be spent exclusively in Member States eligible for funding from the Cohesion Fund).

Specifically for multimodal projects, information is available from the four CEF calls launched so far. Table 15 below presents the main findings, organising the information in the same manner as for the TEN-T programme in Table 15.

Table 15: Connecting Europe Facility (CEF) co-funded priority multimodal projects (2014-2017)

Year	Multimodal projects				All transport projects		
	Selected projects	Estimated cost [€ million]	EU financing [€ million]	EU co-funding rate	Selected projects	EU financing [€ million]	Maximum funding [€ million]
2017	5	182.6	34.6	19%	39	1 019.8	1 350.0
2016	15	173.2	64.1	37%	152	2 431.5	1 939.5
2015	22	179.2	80.8	45%	195	6 688.7	7 560.0
2014	25	386.6	138.6	36%	276	13 016.6	11 930.0
Total	**67**	**921.6**	**318.2**	**35%**	**662**	**23 156.6**	**22 779.5**

Source: Elaboration of the authors based on INEA[107], European Commission (2014b), European Commission (2015a), European Commission (2016h), European Commission (2017b-c)

Between 2014 and 2017, the CEF calls have already allocated more financial resources (i.e. € 318.2 against € 125.3 million) and co-funded more multimodal projects (i.e. 67 against 54) compared to the previous period, relying on the remarkably increased maximum budget made available for transport (i.e. € 24.05 billion against € 8.0 billion).

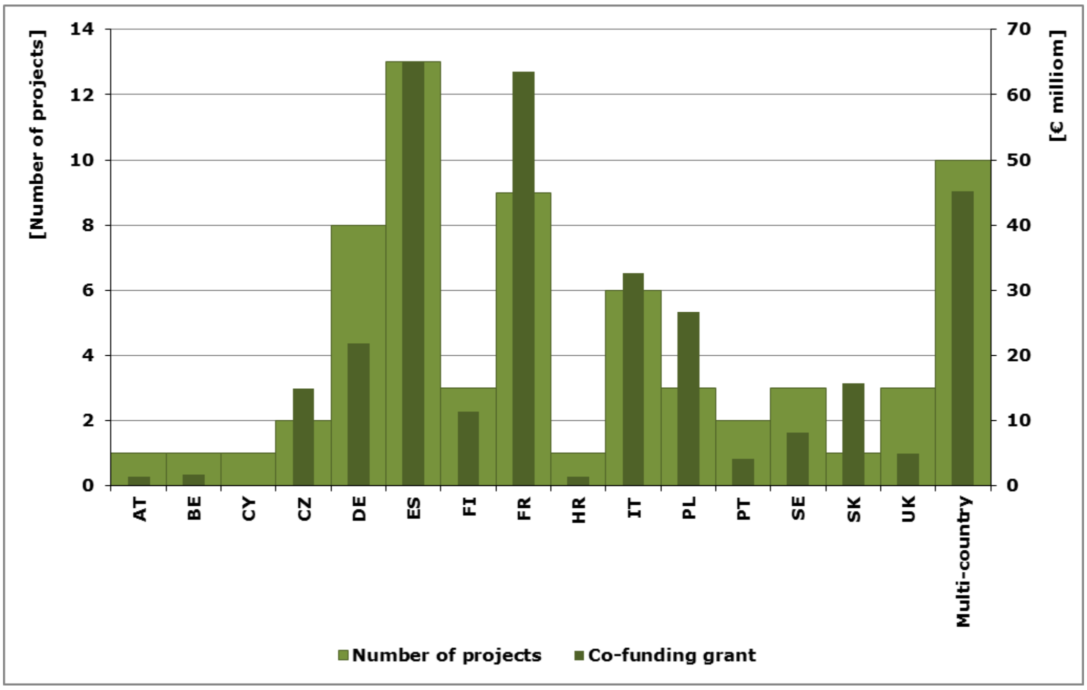
It is worth noting that the allocation of resources in subsequent CEF Transport calls has been declining since the start of the programme, when around 45% of the total financial envelope to be spent was made available for the first call. Not surprisingly, this shrinking trend translates into a decline in the number of multimodal projects selected at each subsequent call, i.e. from 25 projects in 2014 to five projects in 2017. There is still around € 2.8 billion left for the remaining CEF calls until the end of the current period, which suggests that there is a small residual chance for more multimodal projects to be co-funded.

The geographical distribution across the Member States is even more unbalanced in favour of the EU-15 (i.e. 50 projects out of 67) compared to the previous period. Only seven projects involve one of the EU-13, while ten projects involve more than one country. Overall, 13 Member States have not yet been selected to receive a grant for a multi-modal project. At the national level, the highest number of selected multimodal projects were in Spain (i.e. 13 projects or 19.4% of the total), which also received the highest share of grants (i.e. € 65.1 million or 20.5%). Projects in France, Germany and Italy, as well as those involving more than one country, together received a large share of the resources.

[107] Please see https://ec.europa.eu/inea/ten-t/ten-t-projects/statistics.

Figure 30 below presents the distribution of: (i) the number of multimodal projects; and (ii) level of co-funding grants by Member State, which benefited from CEF support for multimodal projects between 2014 and 2017.

Figure 30: Multimodal projects and grants to Member States benefiting from support from CEF (2014-2017[108])



Source: Elaboration of the authors based on INEA website, European Commission (2014b), European Commission (2015a), European Commission (2016h), European Commission (2017b-c)

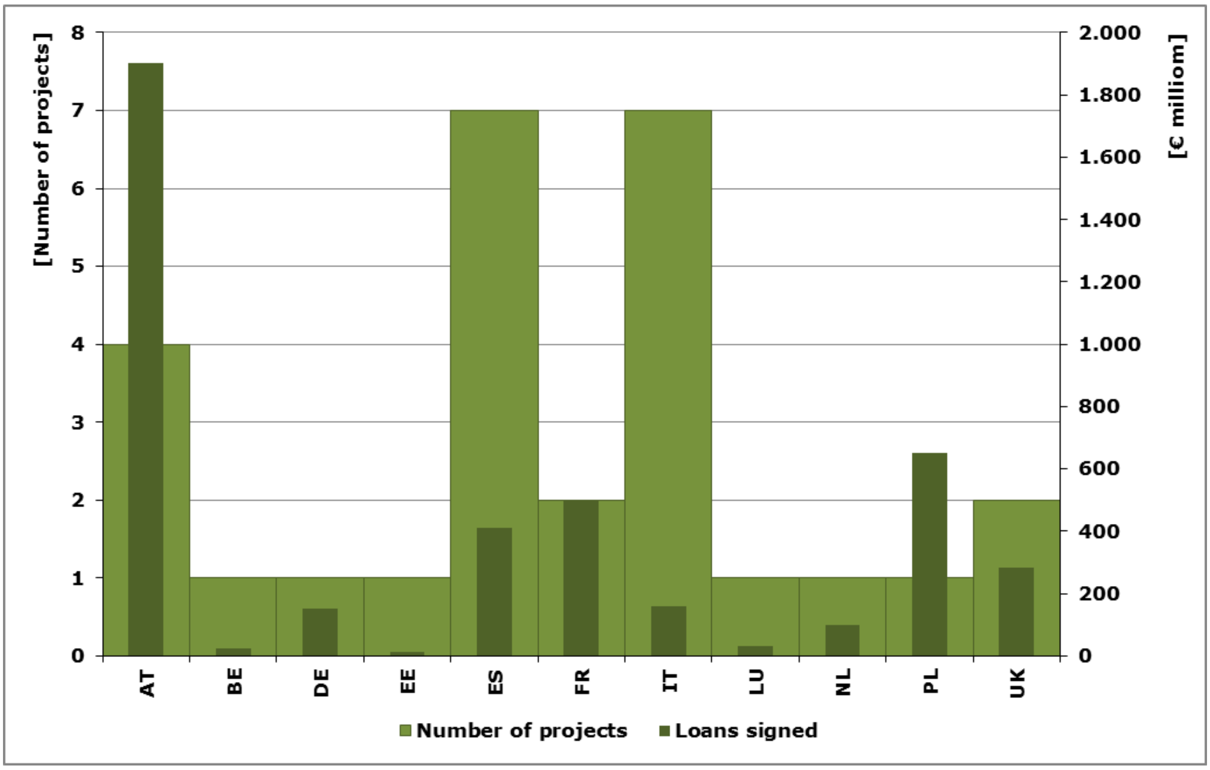
Additional funding possibilities come from the European Investment Bank (EIB) through loans granted on the basis of eligibility criteria (i.e. financial, economical, technical and environmental). The EIB's transport lending policy (EIB, 2011) acknowledges that multimodal projects can: (i) contribute to consolidate demand volumes over long distances; and (ii) reduce greenhouse gas (GHG) emissions per transport unit. For freight transport, this implies the development of projects relying on waterborne and rail transport modes. For passenger transport, better modal choices could result from greater integration of airports, ports, railway, metro and bus stations.

According to EIB database of financed projects[109], EIB (2006) and Beikos (2018), from 2002 to 2018, 28 multimodal transport projects were financed through loans worth of € 4.2 billion in total. Figure 31 below shows the distribution of these projects across Member States. Interestingly, to some extent, it reflects the geographical distribution of selected TEN-T and CEF projects, because with the exception of two projects in Estonia and Poland, all of the other multimodal projects were in EU-15 Member States, and especially, in Austria, France, Italy, Spain and the UK. With respect to transport modes, two projects address passenger mobility, while 26 focus on freight multimodality.

108 Until the first cut-off date of 2017 call.

109 Please see http://www.eib.org/en/projects/loan/list/index.

Figure 31: European Investment Bank's (EIB) projects and loans signed for multimodal projects (2000-2018)



Source: Elaboration of the authors based on EIB projects database, EIB (2006) and Beikos (2018)

4. ASSESSMENT AND FURTHER POTENTIAL

KEY FINDINGS

- **Road freight transport is currently dominant in the EU-28** and long-term prognoses for 2050 suggest that it will maintain its prevailing position. This has been influenced by (i) a reduction of cost of road freight transport over the last years, driven by the growth of the EU-13 countries that have comparatively lower labour costs; (ii) change in demand patterns (decrease of bulk goods and raw materials transport and increase of logistics services demanding smaller and more frequent loads); and (iii) poor quality of rail infrastructure and services in EU-13 countries.
- Since 2010, **rail and sea transport have slightly increased their respective modal shares**, offsetting the corresponding **reduction in that of road transport**.
- **The potential for modal shift is higher where transport demand is concentrated**, which for passengers is in urban areas and for freight where multimodal connectivity and the concentration of shipments is at its highest. **Intermodal freight terminals** could make up for the decline in the volumes of single wagon transport, as they offer additional services, such as warehousing and storage, which makes them more attractive for the integration in dedicated logistic chains.
- **Rail could deliver further modal shift in specific transport demand segments, but at the cost of huge investments**. For passengers, high speed railway (HSR) can compete with air transport, but sometimes also at the expenses of conventional rail. Moreover a genuine European HSR network is still missing. For long distance freight, the slow implementation of the rail freight corridors (RFCs) and **interoperability issues could hamper future developments**.
- **Infrastructure access charges and taxes might induce modal shift,** as shown by the experience in Switzerland and Austria, although their potential is limited by the relatively inelastic demand and the already high level of taxation of road freight transport. To this end, the most promising way would be a general implementation of distance-based charging schemes and the internalisation of external costs (not just wear and tear) in road transport.
- **Technology development and new transport services might encourage modal shift for both passengers and freight**. However: (i) for passengers, it could lead to a modal shift between modes that are alternatives to road; and (ii) for freight, road transport has a higher potential to change compared to rail.

To analyse the potential, progress, barriers and future challenges for the EU in transferring part of its road transport to more sustainable transport modes, the previous chapter presented and described the current situation and relevant trends of the transport sector in the Member States.

Chapter 2 also analysed the measures introduced and developed to foster a modal shift in transport. It did this by, first, outlining the development of transport infrastructure, including:

- the level of multimodal connectivity;
- the completion of the multimodal core network of the TEN-T;
- the implementation of rail freight corridors (RFCs); and
- the development of high speed railway (HSR) and cross-border interoperability.

Second, it analysed the implementation of measures not related to infrastructure, i.e.: (i) infrastructure access charges; (ii) the provision of electronic information in transport; and (iii) the level of EU financing for multimodal transport projects.

Building on these, the purpose of this chapter is to assess the extent to which there is further potential to shift part of the existing road freight and/or road and air passenger transport to more sustainable modes, in line with the goals of the 2011 White Paper on transport and always keeping in mind that modal shift has to be seen as part of a broader strategy to reduce the environmental footprint of transport and optimise the use of transport capacity.

The structure of this chapter follows that used in Chapter 2 and 3. Table 16, at the end of this chapter, qualitatively assesses the further potential for modal shift in EU transport.

4.1. Market modal share of each transport segment

The 2011 White Paper on transport envisaged that 30% of **road freight** over 300 km should shift to other modes, such as rail or waterborne transport, by 2030. This was to be achieved by optimising the performance of multimodal logistic chains, as well as by making greater use of more energy-efficient modes.

According to the available data analysed (please see section 2.1), there was **no significant shift between modes in the period 2010-2016**. **Road freight transport** remains the **prevailing** mode for carrying goods. However, in recent years rail and sea transport have slightly increased their modal shares, reversing the previous negative trend since 2010, while there has been a corresponding reduction in the modal share for road transport. The modal share for inland waterway (IWW) was unchanged.

Looking at overall figures for the EU-28, **in terms of total tonnes** transported, the data suggests that **for distances over 300 km**, the current share of alternative modes is similar to that of road transport, especially for rail which accounts for more than one third of the demand in this segment. However, the objective of the 2011 White Paper on transport, **to shift an additional 30%** of the goods moved by road in 2010 to other modes, **is far from being achieved**. With respect to this goal, it is also worth observing that there is **no explicit indication in the 2011 White Paper on transport of the unit of measurement** that should be used to quantify the proposed shift in demand.

Based on the description of the modal shares in section 2.1, **different patterns can also be observed for EU-13 and EU-15**, by analysing data for road and rail in terms of t-km. For the EU-15 Member States, the modal shares have been relatively stable over the 2000-2015 period, although rail has narrowed the gap to road a little. On the other hand, for the EU-13 Member States, the modal share of rail has more than halved, from more than 40% to around 20%. This suggests that if further modal shift could be achieved, it cannot be done evenly across the EU. In general, the higher responsiveness of road transport to changes in industrial production and logistic chains makes it more difficult for rail to recover its lost modal share.

The existing modal split has been influenced by a **reduction of cost of road freight transport over the last ten years**, driven by the growth of the market share of Eastern EU countries that have comparatively lower labour costs**, in particular in international transport.** Over the same period, **the costs of transporting freight by rail have not reduced in a similar way.**

The **performance of rail in the EU-13 countries** could be explained by the following reasons. **First, the railway infrastructure is generally of low quality** due to a lack of adequate maintenance since the fall of the former, Communist regimes. In this respect, a recent study of the European Commission (European Commission, 2014c) found that the quality of railways in the EU-13 is below the EU-28 average, although it noted that there are programmes in place to tackle the underdevelopment of the infrastructure focusing on the modernisation of the main lines. However, the study also points out that railways capacity in the eastern Member States is currently too large for the current levels of demand. **Second, there has been a change in demand patterns.** In recent years, the demand for bulk goods and raw materials, traditionally carried by rail, has been decreasing. Modern logistics is demanding smaller and more frequent loads that are better suited to the flexibility offered by road transport. Furthermore, in the EU-13, the availability of facilities for intermodal transport are relatively less developed and not as dense as in the EU-15.

IWW is a feasible alternative in only a few Member States, i.e. those which have favourable geographical conditions. It has **some advantages**, because IWW services are provided in a competitive market, as is the case for road transport. This means that there could be some scope to optimise the overall performance of IWW and thus contribute to the modal shift objective of the 2011 White Paper on transport. **However, any improvements would certainly be limited as a result of the geographical scope of this mode[110]**.

As far as **passenger transport** at the EU level is concerned, **the vast majority is undertaken by private car**, although the modal share decreased slightly – by 1.7% – between 1995 and 2015. Over this period, buses and coaches also lost 1.4% of market share, while the share of rail remained basically unchanged (increasing only by 0.1%). The only mode to significantly increase its modal share over this period was air transport, which increased its share by 3.3%.

4.2. Factors driving decisions for choosing a specific mode of transport

Transport demand derives from other needs or activities (e.g. labour, education, leisure, consumption, production, etc.; please see section 2.2). In general, the volume of transport depends on **the cost and time involved, e.g. in accessing activities and services, or in transporting goods. Indeed generalised costs[111] can be considered as the main factor behind a decision to travel or ship a good**. Therefore, policies and measures that **influence the cost** component of the generalised transport cost have the potential to further influence modal shift.

For passenger transport, **road pricing measures** can drive demand from private road transport to alternative transport modes. In particular, in urban areas, where the population density is the greatest (please see section 3.4), transport demand is concentrated and alternatives to private car travel are more likely to be available. Moreover, if combined with improvements in the quality of the alternatives that lead to a reduction of the travel time gap between the private car and other modes, **journey optimisation** could help further. This makes important to ensure that there are **seamless interchanges, intermodal integration (e.g. timetable and ticketing) and easy access to information**.

The decision to switch modes can also be influenced by making the **users aware of the relative environmental impact of different modes**. This can discourage car travel and incentivise more sustainable behaviours. Notably, campaigns should be implemented to make users aware that cars are less energy-efficient and more harmful in terms of local pollution (i.e. air and noise emissions), global warming, congestion and accidents. Measures in other sectors could also drive more sustainable travel behaviour, including fiscal policies in the housing market, land use planning and labour policies that encourage smart working and teleconferencing.

[110] For example, as far as the Danube River is concerned, the Rhine-Danube CNC study (European Commission, 2016c) found that all its core river ports are already connected to the rail and road networks and that bottlenecks are mainly related to navigation limitations, rather than to lack of the inland connections. It is also worth observing that: (i) dredging is needed due to wide seasonal and annual variation in sediment volumes; and (ii) the Danube river acts as a country border, also between EU and non-EU countries, making the allocation of maintenance costs and the timing of the implementation of works difficult to plan and implement.

[111] The generalised cost is usually computed as the sum of monetary costs (e.g. fares for public transport, perceived operating costs and tolls for private modes), plus the value of travel time, which is calculated in equivalent monetary units.

In order to encourage **freight forwarders** to use modes other than the road, alternatives need to be made more competitive and reliable. First, this could be achieved by improving service quality through better planning, application of **ICT-systems and adoption of an integrated supply chain approach** (Islam et al., 2016). Second, on the regulatory side, more flexible regulations on the maximum weight and height for HGVs used to carry goods to and from rail freight terminals could be introduced.

4.3. Rail network density and multimodality

From the perspective of the development of the network, the goal of the 2011 White Paper on transport was to achieve a **high-quality and capacity multimodal core network by 2030. Currently, the level of completion of the core network is low** for conventional rail, and even lower for the high speed railway network (please see section 3.1.2). On the other hand, the development of the IWW core network is progressing well, with 11 countries out of 19 having completed their networks by 2015.

Basically, as far as railways are concerned, there is no a shared and concerted transport policy across all Member States and a sound vision is missing to change railway technology and organisation to increase its effectiveness. This is also combined with budget constraints that are slowing the completion of the rail core network.

Multimodal connectivity is at its highest in the Benelux and western Germany macro area, where a high concentration of sea and inland ports is as extensive as the network of roads, rails, airports (including main hubs) and further multimodal facilities, such as intermodal freight terminals. To some extent, in Spain rail services have also been introduced to link ports to the wider network, thus increasing the transhipment of containers from maritime to rail transport[112].

Figures showing the scale of EU and EIB financing to support multimodal projects from 2000 to date show that funds have been channelled in line with the EU transport policy objectives that have been set. Focusing on freight and considering the **increasing share of unitised transport** in different modes, and especially for rail and maritime (both short and deep sea shipping), this could suggest a **positive impact of the investments that have been made** as it is likely to have had some effect in shifting unitised goods from road to other modes.

In order to deliver further modal shift for both freight and passenger, EU **multimodal policy should focus on where it is likely to have an impact,** especially in the areas where there is the highest concentration of shipments. Intermodal freight terminals are important in this context, being the interface between transport modes and thus key in providing access to multimodal transport services and ensuring efficient and competitive intermodal supply chains.

Intermodal freight terminals could also make up for the decline in the volumes of single wagon transport[113], as they offer additional services, such as warehousing and storage, which makes them more attractive for the integration of different activities in dedicated logistic concepts. The number of intermodal freight terminals is expected to rise, especially in those countries where single wagon transport is expected to decline (European Commission, 2016a).

The analysis of **last-mile transport infrastructure in** EU Member States provides interesting conclusions from the perspective of multimodality. The number of rail dedicated types of last-mile infrastructure is in itself an indicator of relevance for rail freight in the EU. In this respect, the study of the Commission of 2016 provides an overview of the occurrence of the four main types of last-mile infrastructure and shows a

[112] This is reflected also by the number of multimodal projects and funds granted to Spain under EU programmes and EIB loans.

[113] A single wagon transport is a wagon used for general cargo purposes and that can be added to a train at an intermediate station, between its origin and final destination. A single wagon transport is not part of a unit, or block train, which instead travels between its origin and final destination without intermediate stops.

significant growth in these in recent years in nearly all of the EU Member States. **This suggests that the level of functionality and quality of the EU-wide multimodal TEN-T core network could improve** in the future.

The development of new systems and technologies could also increase the attractiveness of intermodal freight terminals, e.g. **from the automation of freight train feeder services** over short distances, for example for the journey from the seaport to the marshalling yard and from new transhipment technologies than can reduce the actual need for marshalling yards[114].

4.4. Rail freight corridors

To some extent the level of **implementation of rail freight corridors (RFCs) also seems to be lagging behind schedule**. In 2014, the International Union of Railways (UIC) and other railway organisations called for better cooperation amongst rail infrastructure managers, and between infrastructure managers and railway undertakings, as well as the **necessity for the cross-border harmonisation of technical, operational and administrative processes** (please see also section 3.1.3). UIC also stressed the lack of statutory requirements for coordination across RFCs.

To accelerate the implementation of the core network corridors (CNCs), the Commission has invited all Member States involved in a specific corridor to come together to deploy results from research and innovation, share best practice and promote new ideas and concepts. Promoting cooperation and coordination of all relevant stakeholders (i.e. national and regional authorities, infrastructure managers, rail undertakings and users) is a key factor for implementing multimodal and efficient RFCs (Balázs et al. 2016). A different approach has been developed for cross-border freight projects. Under the coordination of the RFCs, the "one-stop-shop" approach has been chosen to facilitate the management of international trains, thus bypassing the need for such trains to address separate requests to all of the infrastructure managers responsible for different parts of the route.

4.5. Rail network interoperability

Numerous interventions and policy measures have been implemented at the EU level with the aim of achieving **rail interoperability. However, interoperability within the sector is still far from being achieved**, because the European rail network is still a patchwork of national networks, with different standards and technologies.

Even though an important technological development paving the way for rail interoperability at the European level has been put in place, namely the European Rail Traffic Management System (ERTMS), cross-border traffic is still problematic[115]. Different Member States still use their own national systems[116]. Similarly, Member States tend to use different technologies when developing their national high speed railway networks. These have been developed to be independent, national networks, with their own signalling systems, a variety of technical solutions for power supply (i.e. voltage) and even different track gauges.

114 Currently, containers are lifted vertically onto wagons with a portal crane, but new technologies can load containers from the side under the catenary, or move articulated tracks on platforms (e.g. "modalohr" technology). This could make operations quicker and cheaper for smaller intermodal terminals. For large intermodal terminals containers could be automatically processed on automated vehicles from ships to a marshalling point (e.g. at the Hamburg port).

115 The ERTMS deployment plan sets targets dates until 2023 by which about 30-40% of the CNCs shall be equipped with the system. In 2023, the ERTMS deployment plan will be updated setting out the implementation schedule for the remaining part of the CNCs between 2024 and 2030 (European Commission, 2017d).

116 For example, ERTMS has been fitted in trains in Italy, but not in Germany and France, because they already have their own systems. This prevents rail undertakings from entering other rail networks.

A **lack of common technological development** in rail is not in line with the 2011 White Paper on transport goal to optimise the performance of transport modes and to achieve a fully functional EU-wide TEN-T core network by 2030. This could hamper the further potential for modal shift by maintaining barriers to a full interoperability of the networks.

A challenge with introducing new technologies on rolling stock, is that the lifecycle of locomotives, wagons and coaches can be very long (e.g. 40 years). While automated trains are already operating in urban transport networks (e.g. automatic metro lines), these are not currently in service in conventional rail networks. Safe and efficient operations could be possible in open networks, and probably more easily than on roads, but new standards (e.g. ETCS level 3), pilot applications, regulation and integration of regulation authorities would be necessary, for example to develop automated feeder freight trains.

4.6. Implementation of the high speed railway

For medium- and long-distance passenger demand, high speed rail can induce a modal shift, as it is an alternative to travelling either by car or air over certain distances (European Commission, 1995; European Commission, 2011a). According to Albalate et al. (2014), population density, the location of urban nodes and the distribution of economic activities (such as production, services, administration, etc.) are key determinants for the potential competitiveness of high speed railway with other modes.

In general, **high speed trains** have a competitive advantage over other modes of transport: (i) up to a distance of 300 km compared to travelling by car; and (ii) in the range of 300-600 km compared to travelling by air[117]. In particular, high speed services up to a distance of 500-600 km may divert a significant share of passengers travelling by air[118]. The review in Haas (2014) shows that a modal shift may more often come from air to high speed rail, due to: (i) an airline's strategy of cancelling connections which are in direct competition with high speed rail; and (ii) the reduction of conventional train services. The research also suggests that high speed rail may generally induce users to travel less by car, but the evidence is less definitive.

Focusing on Schiphol airport, the study of Savelberg and de Lange (2018) concluded that international high speed services linking Amsterdam with cities in Belgium, Denmark, France, Germany and the UK could shift approximately 1.9 million passengers from flights at 2030. This is equivalent to a reduction of 12 000-25 000 flights[119] per year. With respect to the current ceiling of 500 000 flights per year, it would mean a reduction between 2.5 and 5.0%. The findings of this study show the potential that could be achieved regarding a modal shift from air to rail transport, but mindful of the density of the network in this region and the concentration of cities within the range of distance fitting high speed service characteristics.

Looking at the highly aggregated transport figures on trends in passenger modal shares as presented in Chapter 2, it is not possible to precisely infer to what extent the variations in the modal shares result from an actual shift in demand away from other modes, or if the differences are due to newly generated journeys. However: (i) the significant increase in air transport; (ii) the implementation of the European high speed railway network, accompanied by the increase of high speed services; and (iii) the slowly increasing

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117 These distances are context-specific, because they vary depending on the time taken to travel to and from the terminal/station, parking availability, security control procedures, travel comfort, etc. These issues could be more important than the travel time itself. Nash (2013) considers high speed rail appropriate for a range of 400-800 km.

118 This is because, on average, at the point where the two modes compete, the generalised cost of travelling by rail is lower than the cost of travelling by air (De Rus, 2012). Modal shift is observed to be stronger where high speed trains have a commercial speed of 200 km/h. In this respect, it is worth observing that the commercial speed is affected by intermediate stations. According to Brunello (2018), a 20% reduction in commercial speed was estimated if the distance between intermediate stops is on average equal to 100 km, when comparing to the direct travel between the origin and destination. The impact on commercial speed was found to increase sharply, as the distance between stops falls below this average value.

119 Assuming 150 passengers per aircraft.

demand for conventional train services are useful **points for consideration** in analysing the potential for any further modal shift in transport.

First, the increase in air transport is more likely to be related to newly generated journeys, especially if one considers the proliferation of low-cost airlines after the deregulation, which also brought a significant change in travel behaviour.

Since air transport is by itself internally competitive, both low cost and traditional airlines are less, or even not at all, inclined to take the risk of competing with another mode, especially if: (i) users could be incentivised to travel by train by keeping fares artificially low[120], as in Spain and Italy; and (ii) there is competition between high speed rail undertakings, as in Italy. Compared to rail undertakings, airlines can exploit a higher level of flexibility, as aircraft can be: (i) quickly moved from one airport to another to operate on more profitable routes; and (ii) sold in the secondary market, or returned back to the lessor, if no longer needed in the fleet.

Second, as regards the implementation of the high speed railway, the goal of the 2011 White Paper on transport to triple its length by 2030 seems unlikely to be achieved. The completion of the priority projects of the TEN-T have extended the high speed railway network from 6 807 km in 2011 to 9 154 km in 2018, which constitutes an increase of 34%.

Third, the implementation of high speed railway networks has increased network capacity, and hence room for services provision. Overall, rail passenger activities have increased, but comparatively more in the high speed segment than for conventional rail services. This suggests that it is more likely that a shift has happened within the same mode[121]. This could also be due to the fact that the subsequent four EU rail packages[122] have been conceived to introduce more competition within rail markets, rather than enabling rail to compete with other transport modes.

In terms of modal shift, high speed railway could help to achieve some progress, but drawing from the experiences in the Member States that have already moved in this direction, it seems that the goal could be achieved at the price of huge investments. In general, the implementation of high speed railway is motivated on the basis of regional equity and integration and environmental objectives. But one could raise the question of whether the **same potential shift could be achieved by other investment programmes**, such as fewer high speed railways, and instead a more balanced mix of long-distance, regional and local train services, or other policy instruments.

The Commission's approach to support the implementation of high speed railway seems a partial initiative. Basically, it optimises the development process of the high speed railway networks at national level, without actual control of the progress with respect to European transport policy goals. It would be better if Member States proposed their own master plans for the development of high speed railway and that the Commission set out the initiatives to implement such plans in line with the overall transport policy goals, covering all modes of transport and including both infrastructures and policy measures.

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[120] Rail undertakings could be also subsidised through arbitrarily low track access charges.

[121] Regarding the development of the high speed railway network and the increase of passenger activities, it is worth observing that these two aspects are not necessarily linked. Further extensions of the high speed railway could induce a low increase of transport demand, because of the provision of new services on lines with a lower intensity of use.

[122] The four rail packages have been adopted between 2001 and 2016 to: (i) open rail services to competition; (ii) make national railway systems interoperable; and (iii) define conditions for the development of a single European railway area. The first package adopted in 2001 enabled rail operators to have access to the trans-European network on a non-discriminatory basis. The second package issued in 2004 aimed at accelerating the liberalisation of rail freight services by opening the rail freight market to competition. The third railway package entered into force in 2007 allowing open access rights for international rail passenger services (including cabotage by 2010). The fourth package of 2016 introduced the right for railway undertakings established in one Member State to operate all types of passenger services everywhere in the EU, with the aim of encouraging railway undertakings to become more responsive to customer needs, improve the quality of their services and their cost-effectiveness (please see also https://ec.europa.eu/transport/modes/rail/packages_en).

4.7. Access charges for the use of infrastructures

Another dimension worth exploring in relation to the further potential for modal shift relates to **infrastructure access charges and taxes**.

In general, **road infrastructure access charges are** relatively **low**, especially in the Member States where time-based schemes (vignettes) are applied. In this respect, the way in which the Eurovignette Directive defines road infrastructure access charges is counter-productive, because it is orientated on past expenditures and not on future investment needs. Even though, in most cases, vignettes are relatively cheap, there are some examples of higher charges, which suggests that some modal shift could be achieved using time-based charging systems.

For example, the German road charge **"Maut"**, applicable to HGVs of 7.5 tonnes or above, induced and increase of transport cost which resulted in some modal change in the short-term. In the long-term, it is expected to produce little modal shift in favour to rail, because of the higher efficiency and flexibility of road transport. In Austria, the relatively high modal share of rail freight is the result of a mix of regulation and high road charges. **Austrian motorway charges are very high** compared to those of neighbouring Member States (e.g. for an HGV above 12 tonnes, the fee is twice as high as in Germany and Italy). The regulation of trans-Alpine traffic (and its enforcement) is also important. For example, freight that can be easily carried on rail is not allowed to travel by road through the Brenner Pass. Between **Denmark and Sweden**, the access **charges** for use **of the Øresund** Bridge **have been set high for cars** and that induced commuters to travel more on regional trains. In this case, the two countries also managed to **overcome the different rail standards by fixing interoperability problems**.

Time-based access charges for the use of road infrastructure only partially include the external costs of transport, and if environmental charges are applied (for example for emissions of air pollutants and noise), they are very low. The case of Switzerland shows that **high road access charges for HGVs** (i.e. around three times as high as those in Germany and France), **fully internalising external costs**, can be of some help in shifting transport from road to more sustainable modes of transport. Moreover, as for road user charges applied in Switzerland, the revenues earned through internalising the external cost can be earmarked to **cross-fund rail investments, if necessary**.

As far as taxes are concerned, the study of Schroten and Hoen (2016) on road charges and taxes found that **road transport already pays high taxes**. When put together, the revenue from fuel excise duty, vehicle ownership and registration taxes (including VAT) and infrastructure access charges exceeded infrastructure costs in 2013 (i.e. yielding € 286 billion against € 178 billion). Although the **"user pays" and "polluter pays" principles are still not fully applied** on all transport modes in line with the goals of the 2011 White Paper on transport, the road transport sector is already a net contributor to governments' budgets, i.e. fiscal revenues earned from road transport taxes and charges are higher than public spending in this sector.

In this respect, and specifically regarding **long distance transport** in view to achieve the goal of 2011 White Paper on transport, **distance-based charging schemes and the incorporation of external costs** (not just wear and tear) in road charges could help to: (i) deliver a fairer implementation of the "user pays" and "polluter pays" principles; (ii) improve the efficiency of transport activities; and (iii) **enhance the potential of modal shift**. However, the charging level should be reasonable to avoid market distortions[123].

[123] For example, on long distance travel, a partial road pricing system only on motorways could generate opposite effects, diverting traffic to another route which is free of charge.

4.8. Technology development

Technological and digital developments are expected to influence the travel behaviour of passengers and freight forwarders in the next 10-15 years, as more digitalisation, intelligent digital support systems and automation are expected to be introduced.

For passengers, progress can be made in a number of directions. First, timetable and information integration will help in strengthening the connectivity between transport services, especially at interchanges. Second, journey planning applications and ticketing integration will help to facilitate and optimise users' travel. It is more likely to expect that this progress could bring more benefits where transport demand is concentrated and services are dense, namely in urban areas.

In principle, rail freight transport should gain an advantage with increased digitalisation, because it is a centralised system, unlike road transport. However, in the recent past **industry has invested more in the digitalisation of road transport, thus reducing the initial advantage of rail**.

In general, rail technology needs decades to change[124], infrastructure cannot be built, or modified quickly, and most modern technologies must be implemented step-by-step and not all at once for the entire network. Despite this, further potential for modal shift could be possible from new technologies, which could be tested on major corridors (e.g. the CNCs), after which it would need to be decided how best to spread the technology throughout the whole network in a coordinated and harmonised manner.

For the **road freight sector, truck platooning[125], as well as the introduction of automated and electric trucks,** could have a potentially significant impact in the future, even if their application was only limited to motorways or the only technical improvement was to the battery range and an increase in the availability of charging infrastructure. Notably, the development of these systems could further increase the cost effectiveness of road freight, making it more difficult for rail to compete. Indeed, a large proportion of the operating costs of the road freight industry is related to the drivers; therefore, if the technology can reduce the number of drivers, the operating costs will decrease significantly[126]. On the contrary, more automation for rail would have less of an impact, because the wages of locomotive drivers constitute a lower proportion of the total cost of rail operations.

4.9. Progress in urban areas to integrate local, regional and international traffic

At the urban level, a mix of technology, pricing and access policies, and better organisation in providing transport services[127] could benefit modal shift. In large and medium-sized cities, sharing systems (i.e. for use of bikes, motorcycles and cars), electric mobility, ticketing integration and regulating access to urban space could help to reduce demand for conventional car travel.

For example, the cases of London, Milan, Gothenburg and Stockholm show that urban road pricing, car bans in sensible areas, high parking fees and the introduction of alternative modes could bring positive effects in terms of modal shift. Urban road charging can be set up not only with the aim of reducing conventional car travel, but also to raise revenues for new public transport services, or infrastructure. The chance of successful implementation of pricing measures depends on: (i) learning the lessons of similar measures that have worked well in other cities; (ii) providing clear explanations to citizens (and taxpayers)

124 For example, the current ETCS system is level 2 and its development and implementation begun in 2000, namely almost 20 years ago.

125 Truck platooning is the linking of two or more trucks in convoy, using connectivity technology and automated driving support systems. The trucks in the convoy automatically maintain a set distance between each other when they are connected for certain parts of a journey (e.g. on motorways).

126 The impact of automation on road haulage cannot be easily predicted, because drivers' responsibilities are not limited to driving only and often they do more than simply drive, like supervision of loading and unloading operations.

127 Integrating services of different transport modes, coordinating timetables and improving access to information.

of the expected benefits of the measures and (iii) presenting the measures in the context of the global vision for the local transport system.

Regarding alternative modes, such as shared mobility systems, it is worth remarking that their attractiveness is a potential challenge to all modes and **a modal shift could be induced not only from conventional cars, but also from public transport**. In cities, evidence suggests that fast and reliable public transport like **tramways, with priority lanes and separated tracks**, and metro lines are an **attractive alternative** to conventional cars. The introduction of shared space designed for pedestrians and cyclists, alongside measures to reduce the dominance of cars, can also be interesting options, but it could also be challenging to introduce these in cities that were not originally designed with shared space in mind.

It is also important to combine these measures in a multimodal perspective to facilitate the use of public transport at interchanges facilities (train stations or airports where feasible) allowing users to travel seamlessly between transport modes and plan efficiently their journey. The potential for social, environmental and economic benefits of multimodal mobility via, continuous access to travel information, planning and mobility services, as well as ticketing integration and payment, could be significant.

Door-to-door (self)mobility management is experiencing a fast growth in terms of potential and opportunities. The advent of the internet and more recently social networks and smartphones, enable **people to be constantly connected and informed**. Transport operators and services are making the most of these opportunities. By incorporating real-time and personalised information, online travel services have enabled more options for multimodal mobility, as well as more accessibility, transparency and availability to nearly every user.

More options to plan and organise a journey, especially at the urban level, where the bulk of passenger demand is concentrated, could change the future outlook for modal share. However, **the risk is that the shift could materialise also between modes alternative to car**.

To improve transport efficiency and the use of information systems, it is also necessary to **ensure the integration of information, management, ticketing and payment**. These steps are closely linked with each other by the data they use, as well as by infrastructure and communication channels. As long as all the elements are in the hand of one operator, their management is quite straightforward. On the contrary, this could be more challenging when different operators (and systems) have to be integrated, as operators could be reluctant to disclose and share sensitive information.

4.10. Summary of the assessment

Table 16 on the following pages summarises the main findings that emerged from the assessment conducted for the purpose of this study in terms of relations between the progress in the implementation of the 2011 White Paper on transport and the further potential for modal shift.

It cross-checks the overview of progress with the potential for further modal shift. The evaluation is qualitative (i.e. low, medium and high) and expresses the strength of the relation between the progress in the implementation of the measures listed and the objective of modal shift, taking into account also other issues such as: the sustainability in the longer term, the effect on transport competitiveness, the role of technological development. Where possible the evaluation is also provided separately for passenger and freight modes.

Table 16: Assessment of the relation between progress and potential for further modal shift in the EU transport

Progress	Mid-term potential of transport modal shift from road to rail and waterborne modes	Sustainability in the longer term	Achievability of the 2011 White Paper on transport goals	Effects on transport's global competitiveness	Chance of technological and digital developments to stimulate or hamper modal shift	Other challenges for the development of multimodal transport that need special attention at EU, national, regional and urban levels	Other relevant issues regarding modal shift
Level of multimodal connectivity, including density of the railway network	MEDIUM	MEDIUM	LOW	LOW	MEDIUM/HIGH (automation & technology)		More advanced in Benelux and Germany
Completion rate of multimodal core network of the TEN-T	LOW Road/Rail HIGH inland waterways	HIGH	LOW	LOW	MEDIUM	Lack of interoperability	Lack of consistent EU strategy for HSR
Implementation of the rail freight corridors	MEDIUM	MEDIUM	LOW	LOW	MEDIUM	Lack of interoperability, harmonisation, administrative process	
Implementation of the high speed railway	HIGH	LOW	LOW	MEDIUM	LOW	Lack of interoperability / network developed at national level	
Access charges for the use of infrastructure	LOW	LOW (road inelastic)	LOW	LOW	LOW	Time-based road charges	
Establishment of the framework for European MIMP	Freight (Rail LOW, Road HIGH) Passengers HIGH	HIGH (market-driven)	Freight (Rail LOW, Road HIGH) Passengers HIGH	Freight HIGH Passengers HIGH	Freight HIGH Passengers HIGH	-	Rail mature -> less opportunity to change, Road bigger -> more opportunity to change

Progress	Mid-term potential of transport modal shift from road to rail and waterborne modes	Sustainability in the longer term	Achievability of the 2011 White Paper on transport goals	Effects on transport's global competitiveness	Chance of technological and digital developments to stimulate or hamper modal shift	Other challenges for the development of multimodal transport that need special attention at EU, national, regional and urban levels	Other relevant issues regarding modal shift
Establishment of a digital framework for electronic information exchange and transport management in multimodal transport	LOW	MEDIUM	MEDIUM	MEDIUM	MEDIUM	-	-
Cross-border interoperability of European transport system	LOW	HIGH	LOW	LOW	MEDIUM	Long time for deployment	Lack of common technological development
Progress in urban areas to integrate local, regional and international traffic	MEDIUM	MEDIUM (shift between alternatives)	HIGH	MEDIUM (alternative modes)	HIGH (digital/MaaS)		
EU financing engaged in supporting multimodal projects and share in total EU financing of transport projects	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM (automated rail vehicles)		Focus where the highest concentration of shipment is

Source: Elaboration of the authors

5. IDENTIFICATION OF MAJOR BARRIERS

KEY FINDINGS

- **Three cross-sectional barriers** have been identified relating to the **lack of a level playing field** between the modes. First, it is important to ensure that all modes of transport pay their full external costs. Second, the way in which different modes are taxed differs between modes and across Member States. Third, in many Member States, company cars, and the fuel that they use, receive favourable tax treatment.
- **Specific barriers for rail freight are:** (i) an ongoing lack of cross-border interoperability; (ii) the complexity of transport chains, which is a particular challenge for multimodal chains; (iii) the slow implementation of the measures needed to deliver a single European rail transport network; (iv) a slower technological innovation in the rail freight sector; and (v) a lack of coordination and sufficient exchange of information between rail undertakings.
- **Specific barriers for IWW are:** (i) high costs resulting from a lack of intermodal infrastructure; (ii) the navigability of rivers resulting from climate change impacts; (iii) missing links; (iv) lack of willingness to share customer data as a result of concerns around confidentiality; and (v) the lack of availability and transparency of freight flow information in combination with limited ICT facilities.
- **Specific barriers for medium-distance passenger transport are:** (i) an insufficient development of the high speed railway network and thus a low level of service; (ii) challenges posed by other transport modes, particularly in terms of convenience and price; and (iii) a lack of competition in the high speed railway services.
- **Specific barriers in urban areas are:** (i) transport and land use planning that has facilitated the use of private motorised vehicles above other modes; and (ii) lack of integration within public transport.
- Beyond the identified barriers, the **reliability and flexibility of road transport drive users' modal choice**. It has essential advantages for personal mobility as well as for goods, as long as the infrastructure that it uses is not congested.

As discussed in the previous chapters of this study, road transport is the prevailing mode as it has clear advantages compared to other modes of transport, for a large part of the intra-EU freight and passenger market.

For **freight**, road transport enables the provision of door-to-door services for almost all origin and destination combinations, as it has a dense and widespread network. On average, at the EU-28 level, the road network is around 26 times longer than the rail network, e.g. for France and the Netherlands, the ratios are 38 and 45, respectively. For each of the other main transport modes (rail and IWW, and also for short sea shipping - SSS), there is nearly always a need for an initial and/or final leg of the journey to be carried by road. Therefore, the vast majority of goods moved are, at least once per trip, loaded onto a road vehicle: the challenge is how to make use of multimodal solutions more advantageous. **The shift** is not from road to rail, or from road to IWW, but **from road to multimodal solutions** involving road and either rail, IWW or SSS.

In addition to the extensive road network and the simplicity of having to rely only on the service of one operator to transport goods by road, road transport has become competitive in terms of time, flexibility, reliability and in many cases also in terms of costs. Furthermore, modern supply chains are more and more characterised by smaller and frequent loads, so do not need the economies of scale that are traditionally the rationale for using alternative modes such as rail, IWW or SSS.

On the **passenger** side, the use of a personal, motorised vehicle (usually a private car) is the only option in many situations, particularly in rural areas, and is, in general, the preferred mode of transport providing the largest freedom of movement to most EU citizens. The potential to reach almost any destination by private car gives an incomparable advantage to private cars in comparison with other modes.

However, as stated above, there are sectors of both freight and passenger transport in which modal shift is achievable as well as desirable as a means of contributing to the overall goal of decarbonising the transport sector. Hence, modal shift policy should aim to facilitate modal shift in those cases where it is achievable, efficient and sustainable.

In Chapter 2, various factors that determine modal choice were discussed to explain why in many cases a traveller, or a shipper, does not choose a multimodal solution. In order to provide a comprehensive overview of the barriers to modal shift for different modes, it is important to consider the reasons for the existing competitive advantages of road transport. These competitive advantages are effectively barriers to modal shift and, once identified, it is possible to determine how they could be overcome.

Prior to identifying the barriers that influence the performance of each mode of transport, it is necessary to highlight three important barriers that are relevant for all modes:

- **Lack of level playing field between the transport modes -** the need to move towards a level playing field by making all transport modes pay their full external costs is considered as a precondition for the achievement of transport policy objectives. Although there have been many studies highlighting the importance of such an approach, it is still far from being realised in practice.

  For example, passenger and freight rail services are required to pay infrastructure access charges (i.e. for every train-km travelled across the EU). By contrast, even for major roads (i.e. motorways and other main roads), access charges (either vignettes or tolls) are currently applied only to trucks travelling on about 20% of the network in the EU. In some Member States, where there are charges for trucks, these only apply to heavier trucks, so exclude trucks weighing less than 7.5 tonnes, or even those weighing less than 12 tonnes in some cases. An even smaller proportion of passenger transport is subject to any access charge for the use of roads.

  While road transport benefits from lower – or an absence of – access charges, it is subject to significantly higher fuel taxes (please see the following bullet point), so the debate is open, as to whether or not road transport already bears its full external costs. To ensure that all modes do cover their external costs, a clearer policy framework is needed, along with political commitment. Currently, a connection is missing between the long-standing aim of having a Single Transport Policy, in which the external costs are internalised, and the national policies implemented by the Member States.

- **Differences in transport taxation -** as with access charges, the approach to the taxation of transport, more generally, should be harmonised as much as possible between different modes and across Member States, even if this is likely to be very difficult given that taxation is a national competence. This is especially true for the taxation of transport fuels, which varies between different Member States and also within individual countries. For example, different rates of fuel tax are applied to fuel used in aviation and to fuel used in rail transport. This is because the taxation of different modes of transport has often been developed independently at the country level, from that of other modes in each Member State, without giving any consideration to ensuring inter-modal competition. The removal of the present differences in the way in which transport fuels are taxed would also help to move towards a level playing field between the different modes of transport.

Energy (in the form of fuel costs) is a key cost driver in transport. Energy taxation is subject to EU Directive 2003/96/EC[128]. The mandatory energy tax exemptions for aviation and maritime shipping have a knock-on impact for customers, operators and EU transport competitiveness. Some EU Member States levy high taxes on electricity, including for rail, and VAT on cross-border rail travel, while cross-border aviation is VAT-exempt across the EU.

- **Favourable treatment of company cars** - other tax asymmetries in the passenger sector are found in the favourable tax treatment of company cars and their use of fuel. Since in many countries, employees do not bear any additional cost for using a company car for private purposes, the way in which the company car tax framework is structured leads to company car owners choosing to drive rather than use other modes of transport and also encourages them to drive longer distances.

Addressing these barriers requires interventions that go beyond the transport sector and are therefore complex to overcome. However, as highlighted by many experts involved in the debate, applying objectives and policies to a situation in which there are already distortions means that their impact will be subject to even more uncertainty and potentially lead to even further distortions.

In the following sections of the study, the main existing barriers for specific modes of transport are presented and briefly outlined in terms of their relevance to modal shift objectives. Chapter 0 then discusses the measures that would be needed to tackle these barriers, taking into account what has already been implemented.

5.1. Rail Freight

As noted above, in terms of promoting modal shift, it is important to identify the barriers that prevent multimodal journeys. In particular, it is important to identify the factors that translate into rail freight transport being more expensive and less reliable, taking longer and providing a lower quality of service, as compared with road transport. Such factors are essentially the barriers to modal shift and are identified below in Table 17.

[128] Council Directive 2003/96/EC of 27 October 2003 restructuring the Community framework for the taxation of energy products and electricity.

Table 17: Rail-road intermodal transport – modal shift barriers

BARRIER	TYPE	DESCRIPTION
Cross-border interoperability of the railway networks	Administrative, infrastructural, operational and technical	Lack of interoperability in the rail sector is the main barrier when considering cross-border transport (particularly those addressed by the 2011 White Paper on transport objectives). This barrier encompasses various issues including: • lack of compatibility of infrastructure standards (i.e. track gauge, axle load, train length, power supply (i.e. voltage) and signalling); and • lack of harmonisation of rules (including safety, security and certification) and timetables. It is a complex barrier as it is the combination of a series of technical, administrative and infrastructural problems that generate operational problems resulting in: (i) slower transport operations; and (ii) an increase of the operating costs borne by railway undertakings. The lack of cross-border interoperability is still also the main problem in increasing EU railway competition, especially for long distance transport.
Complexity of transport chains	Operational (mainly) and technical	Multimodal chains involve different modes, and so require collaboration between a multiplicity of operations and operators. This generates organisational complexity, which presents a challenge to potential users who might otherwise take advantage of multimodal transport. Pre- and post-haulage operations require a good synchronisation of activities, which may generate an excessive additional cost. Solutions need to be found to streamline the process and to reduce the burden on the terminals in terms of the complexity of their operations, including with respect to both road haulage and the handling of load units.
Quality and density of the network	Technical and operational	The quality of the railway network can be measured against standards for a number of characteristics (i.e. train length, maximum train weight, axle load, admitted *gabarit* size[129], etc.). Any deviation from the assumed standards limits the dimension of the train allowed on a track and severely limits the competitiveness of multimodal solutions. The density and quality of intermodal terminal infrastructures are also key parameters to be considered,

[129] The size of the *gabarit* indicates the loading gauge limits of rail cars and wagons that can be conveyed on a section of railway line.

BARRIER	TYPE	DESCRIPTION
		when assessing the potential for shifting goods to rail. However, this is a "chicken-and-egg" problem, as density and quality can be easily and quickly improved in areas where more traffic originates. The quality of intermodal terminals includes, amongst other factors: proximity/connection to productivity areas and the road network; availability of longer operating tracks; efficient terminal operations; capacity to handle different type of cargo; and load units.
Opening of the market	Administrative and legislative	Despite the fact that the rail transport market was opened to competition in 2007, there still remain many obstacles and the implementation of a single European rail transport network proceeds at a slow pace. The slow and partial implementation of ERTMS technology demonstrates the wider challenges the sector faces. Whilst infrastructure managers may agree that there is a need for common standards, each wishes to have his own standards implemented EU-wide. On the other hand, in the road transport market, the vehicles of each manufacturer can be used throughout the EU network. The rail sector is also characterised by the presence of strong trade unions. Wages in the rail sector remain relatively high, and so the industry is not competitive, whereas both the road haulage and maritime sectors are more competitive in this respect.
Technology	Operational and technical	The evolution of technology in rail transport has been slower than in other modes, largely because of the size of the investments needed compared to the size of the market. This represents a barrier for innovation and for efficient transport solutions. For example, the slow introduction of innovation in traffic management and control systems is one of the causes of frequent train delays, thus reducing the reliability of the services. On the other hand, innovations in road transport are implemented faster, due to the very large private investments in this sector, which can be better justified as a result of the magnitude of the market. The further opening up to competition of the rail market may trigger innovation and increase the competitiveness of the EU railway sector as a whole, but the creation of a competitive market has been slow, as noted above.

BARRIER	TYPE	DESCRIPTION
		Bureaucracy and administrative rules have been also identified as barriers to modal shift to rail freight. The high level of bureaucracy that affects many EU railways is still a major problem that prevents the adoption of new models, including new technologies.
Information	Operational	The barrier in this case is twofold: • internally, there is often a lack of coordination and information exchange between rail undertakings, which prevents the development of an efficient and real "synchromodality"[130]; • on the customer side, there is often a lack of knowledge of the market opportunities and a lack of competence to develop supply chain projects involving multimodal solutions[131].

Source: Authors' own elaboration

5.2. Inland waterway transport

Inland waterway transport presents some specific barriers that are more often of an internal nature. Table 18 summarises the most important barriers that currently exist. Some of these are similar to those indicated for rail transport, as they are more generally attributable to the viability of multimodal solutions.

Table 18: IWW-road intermodal transport – modal shift barriers

BARRIER	TYPE	DESCRIPTION
Complexity of transport chains	Operational (mainly) and technical	Shipping freight on IWW often entails high costs, as a result of the need to use road transport to bring the goods to the IWW network from origins that are spread over a wide area, and then take the cargo by road to a wide range of disparate destinations. This is also due to lack of clustering of industrial and logistics sites in the vicinity of terminals and along the waterways. Transhipment and storage costs, including port charges can be high, for example when port dues are levied based upon the gross load capacity of the barge, instead of the actual load volume being transhipped.

130 Synchromodality is the optimally flexible and sustainable allocation of cargo to different modes and routes in a network under the direction of a logistics service provider, so that the customer (shipper or forwarder) is offered an integrated solution for its (inland) transport.

131 For example, the lack of information of the estimated time of arrival has consequences for the whole transport chain and especially for the efficiency of terminal operations, capacity of terminals and road haulage.

BARRIER	TYPE	DESCRIPTION
Navigability	Technical and operational	Climate change is increasingly a challenge to water-based transport. Low levels of water flow in rivers limit the potential to use large boats[132]. There will be an ongoing challenge to keep rivers navigable. This is not helped by the fact that there are often limited opportunities to regulate the water flow of large rivers. Smaller rivers tend to have more locks, making the regulation of water flow easier.
Quality and density of the network	Technical and operational	The Commission had identified inadequate infrastructures (i.e. bottlenecks and missing links) as a major obstacle to inland navigation. The most common types of river bottlenecks and missing links are bridge clearance, adequate waterways and locks. On the land side, a lack of infrastructure and services, terminal equipment, storage facilities and value added services limit the smooth transfer between modes thus inhibiting innovative multimodal concepts[133].
Market cooperation	Operational and administrative	Competition between logistics service providers and the confidentiality of client data result in a lack of willingness to cooperate and share information. This results in fragmented services and a lack of critical mass to set up efficient and high quality intermodal solutions.
Information technology	Technical and operational	Technical and operational barriers are linked to the lack of availability and transparency of freight flow information, in combination with limited ICT facilities, as well as an absence of standards for communication and information exchange[134]. In particular, the absence of real-time traffic information and forecasts about the traffic on the multimodal transport network has a negative impact on the efficiency and reliability of multimodal transport.

Source: Authors' own elaboration

[132] For example, the dry summer of 2018 throughout the northern Europe particularly hit the Netherlands, lowering water levels on the rivers entering the country. As a result, a larger number of barges were needed to transport the same amount of cargo as capacity was necessarily reduced on all vessels.

[133] For example, empty container depots, reefer plugs, container repair facilities, stuffing and stripping services for containers. Other limitations depend on constrained opening hours and the locations that are available for terminal expansion.

[134] Lack of information exchange and collaborative planning results in long waiting times for barges in seaports. This hampers the success of multimodal hinterland transport.

5.3. Medium-distance passenger transport

For the passenger sector, the main objective of the 2011 White Paper on transport is to shift 50% of medium-distance transport from road to rail by 2050. The main contribution to delivering this target should be from the expansion of high speed railway (HSR) services connecting major cities and/or airports, which should be linked to the HSR network.

The use of conventional rail for medium-distance travel is becoming increasingly unattractive in many places due to a reduction in the frequency of services (especially on routes served by HSR) and the competitiveness of other modes of transport (i.e. private cars, coach services and new forms of shared mobility).

General barriers to shifting passengers to rail transport for medium-distance travel are illustrated in Table 19.

Table 19: Medium-distance passenger transport – modal shift barriers

BARRIER	TYPE	DESCRIPTION
Network development	Technical	Insufficient development of the high speed railway network, so that services currently only operate on a limited part of the network.
Competition (internal and with other modes)	Operational	• As with freight transport, multimodal solutions with HSR as the main mode has difficulty in competing with the door-to-door service guaranteed by private cars. • High speed railways services are generally a more expensive alternative to both conventional railway and coach transport. Their competitiveness also has to be measured against air transport. • The lack of a competitive market in the provision of HSR services on the same routes.

Source: Authors' own elaboration

5.4. Urban nodes

At the urban level, modal choice is driven by the criteria highlighted in section 2.2 and the behavioural choices and transport organisation described in section 3.4.

As noted above, to encourage a modal shift from private motorised transport, particularly from cars, it is absolutely crucial for the alternative modes to be competitive in terms of time, convenience, reliability and price.

If the planning of the transport system in a city, including the way transport interacts with land use, has been undertaken to facilitate car use, it will be quick and more convenient for citizens to drive and for local business to move goods by van. If planning has been undertaken in an integrated and balanced manner, i.e. in a way that facilitates the use of public transport, cycling and walking where it is appropriate to do so, there will be a higher modal share of these more sustainable modes. If a public authority needs to change its planning approach from one focusing on the car, to a more sustainable approach to planning urban mobility, it will take time, resources and the need to engage with citizens, businesses and other stakeholders. This is essentially what the SUMPs, and the underlying process of developing them, requires.

There are many different types of policy that might be included in a SUMP, including:

- a more and better quality dedicated infrastructure (and networks of infrastructure) for public transport, cycling and walking;
- the promotion of these modes;
- a better integration between all modes to support intermodality; and
- the introduction and promotion of shared transport (i.e. bike sharing schemes and car clubs) and measures to enable the use of electric vehicles.

Vehicle access restrictions for individual motorised transport – cars and vans – are also important. These can be politically challenging, and so far few local authorities have successfully implemented one of the many different schemes. For these to be successful, engagement with stakeholders and investments in alternatives are fundamentally important.

Although their existence depends on the specific context and characteristics, Table 20 presents specific barriers to modal shift in urban nodes.

Table 20: Urban nodes – modal shift barriers

BARRIER	TYPE	DESCRIPTION
Planning that had previously focused on facilitating car use	Operational, infrastructural, administrative and technical	Transport and land use planning that has focused on facilitating car use has led to: • The unavailability of suitable and effective public transport (e.g. frequent and fast services), some of which need large investments (e.g. suburban rail and metro lines). • The absence of high quality and coherent infrastructure for people who want to walk or cycle. • The absence of high quality interchange facilities that can support intermodality. • Congestion resulting from excessive use of individual motorised transport, which often contain a single person, leading to an inefficient use of limited urban space.
Lack of integration within public transport	Technical and operational	The lack integration of public transport in terms of timetables, ticketing, payments systems and access to information available to the users (this is more frequent when urban operators differ from those operators working at the suburban level).

Source: Authors' own elaboration

6. A WAY FORWARD: MEASURES PROPOSED

KEY FINDINGS

- For several reasons, a significant **shift** to less carbon intensive transport modes is still **far from being** fully **achieved**.
- The **development of HSR** alone does not seem to be sufficient to shift significant volumes and passengers from road to rail. Due to the high costs related to HSR, **investments** should focus only where HSR has the most potential. For **conventional lines,** investments should focus on **upgrading selected sections**, where the potential for modal shift is high. For both HSR and conventional services an **improvement in the reliability of services** is needed.
- With respect to **multimodal freight transport**, the ongoing process of amending the **Combined Transport Directive** is expected to facilitate further the development of multimodal transport. The investment in multimodal projects (e.g. in rail-road terminals (RRTs) or in inland waterway terminals) has been low compared to other infrastructure, so far, which needs to be addressed.
- **Urban areas** – particularly the largest agglomerations – are where significant **modal shift** is more achievable. There are **many measures** that potentially contribute to modal shift in urban areas, including the provision of infrastructure for alternative modes, the implementation of shared mobility and ITS, vehicle access restrictions and the integration of ticketing, payment and information for public transport. Concerns about **congestion** and **pollution** in cities also mean that local residents are more open to using more sustainable transport modes.

The measures set out within the 2011 White Paper on transport and the related objectives responded to a clear and comprehensive intervention logic based on the relevant issues that had been identified and assessed at the time as being important for the creation of the desired Single European Transport Area. Before making proposals for measures to improve the conditions for modal shift, it must be acknowledged that the rationale for the intervention is still valid, as demonstrated by the lack of progress that has been made in some cases.

However, looking at the other side of the coin, it could be argued that the measures undertaken so far have had a limited effect, at least in terms of modal shift. This could be the result of many different reasons, but it must be also noted that it could be too early to evaluate whether the EU is on the right track to achieve the stated objectives and whether the measures have been deployed to their full potential.

The literature reviewed and the judgement of the stakeholders and experts engaged during the study have cast some doubts on the potential of the EU transport system to achieve such ambitious targets as set in the 2011 White Paper on transport. Furthermore, the projections in the Commission's own Reference Scenario (Capros et al., 2016) foresee relatively stable modal shares in future years, even though the scenario incorporates many of the measures set out in the 2011 White Paper on transport.

Together, the analysis presented in the previous chapters of this study shows clearly that progress in implementing specific and key parts of the planned interventions is lagging behind the original schedule. This is particularly in the case of:

- The **development of the TEN-T networks,** in particular for rail**,** which is still slow compared to the original schedule and in some cases, projects are not mature enough to be implemented. The network is, therefore, likely to be completed later than the original target date: this may suggest the need to opt for additional interventions to enhance the performance of the network in the shorter term.
- The **intermodal connectivity** between the networks for different modes is good where it has been developed thanks to strong demand, but is still lacking elsewhere; this may suggest that the interconnections between the networks should be improved in order to enable seamless multimodal transport chains (both for goods and passengers).
- **High speed railway** is currently well developed in only a limited number of Member States. In some cases, there has been a high demand for high speed railway services, particularly in the first years after their introduction (e.g. France, Italy and Germany), whereas elsewhere (e.g. Spain) it is not contributing substantially to modal shift. The first lines that were constructed had the most significant impact on demand, while the impact of additional lines tends to be lower. For this reason, the development of high speed railway is not the only means of enabling passengers to shift from road to rail. There is further potential at the urban and peri-urban level, where commuters' journeys are characterised by high congestion and high cost for car use (i.e. road charging, parking price and availability, etc.).
- The measures **to improve interoperability for rail services,** which have not been sufficient to guarantee a fully coherent and integrated, interoperable network. This is evident even in the EU's major intervention in this area, the ERTMS, which is still far from being implemented and used in all Member States. There are many other challenges faced by cross-border services.

As highlighted in the above analysis, there are sectors or segments of transport demand that have more potential than others to attain ambitious modal shift targets. Positive results in terms of modal shift are sometimes hidden within the high level official figures of modal split. This is the case for intermodal and multimodal solutions for freight that are becoming more relevant for various modes of transport: for rail freight and inland navigation as well as for short sea shipping.

In the passenger sector, there is undoubtedly more potential in urban areas where demand is more concentrated and between urban areas where the demand for inter-urban travel allows the provision of efficient, frequent and reliable rail transport services. Concentration of demand is also key to implement seamless multimodal solutions.

In this context, the measures that can be proposed to help to deliver the existing modal shift objectives are presented below.

6.1. Freight multimodal transport

Many actions and measures have been undertaken to make the most of the potential of multimodal transport solutions. As demonstrated by the analysis of the previous chapters, this is a promising area where there is still potential to increase the market share of modes other than road transport. Some of the measures that are already foreseen will address some of the barriers that have been identified in the previous chapter.

However, it is important to highlight additional or supporting measures that might be implemented, taking account of the factors that determine modal choice, as highlighted in section 2.2.

The development of **infrastructure** should be targeted at three main objectives:

- **To reduce costs, and so to increase the competitiveness, of multimodal solutions**. This is broadly addressed by introducing higher standards, e.g. for train lengths. The introduction of the 740 m standard train length, which is one of the TEN-T standards set to ensure the sustainability of solutions involving rail transport as the main mode, should help in this respect. Additionally, since a major growth sector is the carriage of road semi-trailers, various railway lines will need to be adapted to enable them to take such trains. Both challenges are being addressed by the development of the Rail Freight Corridors (RFCs), even if, so far, the standards are not everywhere respected.
- **To increase the density and quality of intermodal and multimodal terminals** to smooth the modal interchange. Apart from the investments needed to accommodate the longer trains within the terminal, it is important to empower technological solutions, including transhipment methods that enable quicker, cheaper and greener operations. For the larger rail-road terminals (RRTs), solutions may encompass innovative systems in which many of the handling operations can be automated. In the port of Hamburg, for example, containers are carried by automated vehicles from ships to a marshalling point.
- **To boost the level of EU investment in multimodal projects** (e.g. in RRTs or in inland waterway terminals), which has been low compared to other types of transport infrastructure projects. The EU funding in this field should be supported by larger investment in research and development and be targeted at developing and introducing new technologies.

From the **regulatory** point of view multimodal solutions may benefit from the amendment of the Combined Transport Directive 92/106/EEC, which already addresses some key issues at the EU level that should reduce the organisational and cost burdens of combined transport compared to transport that only uses the road. The amendment of this Directive, which is ongoing, is expected to facilitate further multimodal transport by simplifying cross-border procedures, including the provision of additional exemptions to cabotage rules and allowing the provision of economic incentives.

In order to reduce the cost of intermodal transport, the Combined Transport Directive already allows for some exemptions. Of particular relevance is the increase in the permitted maximum weight of such trucks – up to 44 tonnes – when these are used for the initial or final haulage of goods using combined transport.

A further extension of this provision could be to allow longer and heavier HGVs to be used to and from rail terminals. This could enable the transport of larger containers, which can be easily taken by rail. This type of transport is already practiced in countries such as Sweden, where trials have been undertaken using even longer trucks (that are able to carry up to two 45 feet containers). In order to avoid direct competition with rail, clear limitations on the distance on which these vehicles could be used must be introduced and enforced.

Despite the partly negative experience at EU level[135], some grant schemes applied at national and regional level have been successful. This is the case of the Italy's experience with Ferrobonus and

[135] In the past, the Marco Polo programme launched and managed by the Commission tried to contribute at EU level to the shift of international road transport to alternative modes by providing a financial support for the first years to new transport services established. The measure, after an initial success, was later assessed as insufficiently effective by the ECA (European Court of Auditors, 2013).

Marebonus to shift goods away from road, which so far have proved to be effective[136],and, though outside the EU, the Swiss approach.

Additional measures that may enable multimodal solutions are to be found in the domain of ITS. The enhancement of ITS systems for traffic management is considered to be a key investment need by the stakeholders consulted for this report. This would help to improve the quality of intermodal transport by providing real-time information systems to track and trace freight and to manage freight flows. As discussed above, this is currently a barrier when dealing both with rail and IWW transport services. Measures relating to e-freight and to the development of multimodal information platforms also go in this direction; investment in technologies of this kind should have more importance at the policy level and be further supported.

Measures and support aimed at the renewal of the fleet in both rail and IWW sector could also improve the quality of the services offered.

6.2. Medium-range passenger transport

Medium range passenger transport is probably the most controversial segment, as a lack of data does not allow a well-informed understanding of the state of play in relation to modal shift, at least from road to rail.

There is some evidence that high speed railway (HSR) has contributed to modal shift to a certain degree, but the analysis of the high level figures suggests that the impact has not been sufficiently consistent to state with confidence that high speed rail has always been successful in delivering modal shift so far.

For this reason, it might be worth considering whether promoting large investments in high speed railway is always the right priority. In particular, it has been demonstrated that high speed railway can be a success in certain conditions characterised by strong point-to-point demand and over medium distance but, as also highlighted by the European Court of Auditors (ECA), there is no need for high speed railways everywhere. In addition, in some existing high speed railway networks, there are cases where the demand is currently very low (e.g. in Spain), leading to inefficient results.

Since investment in high speed railway is characterised by high costs (and which often over-run), the objective of tripling the HSR network by 2030 might need to be reconsidered in terms of its feasibility, as might the measures linked to it. Instead, the focus should be on the part of the network where high speed railway can be most effective.

Whenever the characteristics of the network do not match the requirements for successful high speed railway investment, policy should focus on alternative solutions, such as upgrading existing conventional lines, which could bring comparable benefits to those offered by HSR services in shorter time and with a lower budget. The Commission could then differentiate between areas, identifying key areas where high speed rail has a significant potential for modal shift, such as the connections between major cities where the passenger flows are higher.

Furthermore, the interoperability of the high speed railway networks built so far is not satisfactory. This can be seen as an additional obstacle to the opening of the market. If the focus of EU policy in this area

[136] The rail traffic in Italy has seen a growing trend over the last years, also thanks to the incentives granted to the railway undertakings. The same happened for Motorways of the Sea (MoS) traffic through the Marebonus incentive. The ongoing CEF funded study 'Med-Atlantic ecobonus' is designing a new effective and sustainable incentive scheme (Ecobonus), which aims to support intermodal freight transportation through the increase of demand for MoS and is aligned with the present priorities of the TEN-T policy.

is changed, as proposed above, this should help to open the market to enable competition on the quality of services and prices of tickets.

The above objectives could be supported by extending the requirement that Member States have to have a coherent national transport investment strategy to all countries that wish to receive support from any EU fund, including the CEF. Currently, this requirement is relevant only to countries that wish to receive support from the Cohesion Fund and ERDF.

6.3. Urban nodes

The vast majority of the EU population lives in urban areas. This makes urban areas the main place where significant modal shift is more achievable, and where examples can be found of good practice, although the extent of the replicability of many of these is highly case sensitive.

From the point of view of the EU, the focus should be on facilitating multimodal access to, and connectivity between, urban nodes, together with the efficient connection of cities to airports in order to integrate long- and short-distance transport. Research, innovation and exchange of experiences are very important in an era where realities are changing: including the need to focus on understanding user needs, work with new mobility services to achieve policy goals, and ensure that the impact of automation is positive, etc.

To some extent, modal shift should become more achievable as people become more concerned about the quality of life in their cities and many have accepted that car use should be penalised in favour of public transport and active forms of travel. Furthermore, in cities with highly developed multimodal transport systems, public transport that has high quality infrastructure and which utilises ITS can be competitive with private car use. This is especially true in cities with high levels of road congestion and/or limited parking options.

Travel needs to be as seamless as possible, which will require extra effort to ensure integrated timetables, ticketing strategies, payment services and information provision, particularly for inter-urban and intra-city travel. Public transport needs to be as good as private transport, in terms of its speed, cost, reliability, convenience and ease of use.

ITS can help to improve the acceptance of public transport as an option, but there are certain conditions: different ITS have to be deployed so that they work together; they have to incur no additional cost for passenger transport users; and be cost efficient for freight transport. In general, in order to successfully apply such technology, there is a threshold after which it is viable that is reached only in medium-sized and large cities that attract large flows of commuters on a daily basis. The challenge will be how to extend these models to smaller cities (between 50 000 and 150 000 inhabitants), where it is more difficult to tailor mass transport systems that serve the needs of everyone in these cities.

Additional solutions and opportunities can be found in the development of shared mobility (i.e. car, scooter and bike), which is growing in popularity and, perhaps in the longer run, will enable a change in mobility patterns, in particular in the centres of larger cities. However, shared mobility is only partially contributing to modal shift objectives, as it is taking market share from both public transport and private mobility. On the other hand, shared fleets are a prime candidate to support the shift to electric vehicles, thus positively impacting on the cities' environment.

It is important to take into account the whole set of impacts of such services: a study prepared by the International Transport Forum (2016) reported that **new on-demand shared mobility services,** if unmanaged, could result in increased distances travelled by car. This was true in particular in medium-sized cities where self-driving shared cars would replace not only private cars but also traditional public transport, thanks to their lower transport costs.

On the contrary, a carefully planned and managed car sharing service can reduce the number of vehicles circulating on roads, the overall distance travelled (-22%) and CO_2 emissions (-27%) (International Transport Forum, 2015). A further study undertaken by the International Transport Forum in the agglomeration of Helsinki found that the introduction of new on-demand shared mobility services is expected to positively impact modal shift (Furtado et al., 2017).

New forms of transport and new consumer behaviours are emerging and can have an impact on car ownership rates, in particular for younger generations, such as car sharing, ride-hailing, self-driving and generally smarter forms of mobility. Car ownership is no longer seen as a necessity at all costs (young people are increasingly embracing the principles underling the shared economy). A detailed report exploring the mobility choices and expectations in terms of car use and ownership for consumers, suggested that approximately 25% of "Generation Y"[137] consumers across Europe do not plan to buy or lease a vehicle before 2019 (Deloitte, 2014).

There are many different policy measures that can be promoted in a city to support modal shift. As discussed above, there has been a significant implementation in the use of SUMPs as strategic instruments to drive the evolution of mobility solutions within cities to meet sustainability objectives, including a shift to more environmentally friendly modes. For the purpose of this study, however, the type of measure can be categorised in the following groups:

- the improvement of multimodal access and connectivity of urban nodes (infrastructure measures);
- the improvement of public transport services (quality, frequency, speed, etc.);
- the promotion of active modes through dedicated infrastructure, such as pedestrian zones, shared space and bicycle paths;
- the integrated ticketing, payment and information, as well as ticketless/contactless solutions, for public transport use;
- vehicle access restrictions, including road (congestion) pricing schemes; and
- the introduction and management of shared mobility concepts.

Generally speaking, the set of measures proposed and adopted within a SUMP responds to policy objectives that are also coherent with wider EU policy.

[137] People born between 1977 and 1994.

7. CONCLUSIONS AND RECOMMENDATIONS

7.1. Conclusions

The 2011 White Paper on transport set objectives for 2030 and 2050 for modal shift, which coincided with the dates at which it called for the completion of the different parts of the TEN-T network (first the core network in 2030, and then the comprehensive by 2050), which provides the backbone for EU transport infrastructure. However, even the date for the achievement of the first set of targets is still some way off, so for this reason it might be too premature to conclude on the achievability of the objectives and then to identify measures to address any failings.

As has been mentioned several times, modal shift is the main aim of some of the actions identified in the 2011 White Paper on transport. The general aim of this White Paper is to decarbonise the transport sector, to which modal shift contributes substantially, but the importance of its role must be considered in the context of other progress that includes amongst others:

- the extent of the diffusion of new technologies such as the electric mobility;
- the implementation of demand management policies; and
- the implementation of green logistics solutions.

All these also drive the decarbonisation process by reducing emissions without the need to deliver a substantial modal shift.

Successfully delivering modal shift is a complex task that requires consideration of many different aspects, such as:

- Transport demand, including its spatial characteristics, and the factors that normally drive passenger or freight forwarders to choose one mode over another.
- The supply of infrastructure and the services offered, as well as the relative indicators of performance (mainly cost, time and quality) for different modes.
- The regulation of the sector, including access charges, subsidies and incentives, as well as the limitations resulting from such regulation at the EU, national and local levels.

The progress achieved so far is reasonable, even though the data do not yet show the expected switch between the modes. Indeed, many measures that have been undertaken will only deliver their desired impact, sustainably, in the medium- to long-term.

Tangible effects can be seen when looking back at time series of data: policies undertaken at the EU and at the national level by Member States have stopped or at least slowed down the growth of road transport, both in absolute terms and in terms of modal share, and have substantially reversed the declines in other modes, particularly in rail transport that in the final decades of the last century had been in steady decline. This is also the result of the resources that have been allocated to the rail sector, which has absorbed the majority of EU funding for infrastructure development, specifically addressing cross-border connections and interoperability.

Modern logistics is characterised by requirements of high flexibility, as well as high quality and reliability, of the services offered. This is the area in which modes other than road transport have so far failed to increase their modal share. Addressing this entails, as has been highlighted several times, the coordination of different operations and different operators that work together along a complex multimodal chain. Such complexity clearly limits the potential for shifting goods away from road.

Transport operators and stakeholders are generally in favour of modal shift, but believe that this should not be obtained by penalising road transport, particularly considering the large investment that has been made within the road transport sector to limit its environmental impact. From this point of view, the lack of a level playing field in relation to external costs seems still to be an important open issue. This, together with the different approaches to, and levels of, taxation between modes and across countries, jeopardises the effectiveness of other actions taken and undermines the rationale for supporting policies to deliver modal shift.

7.2. Recommendations

The main recommendations for policy actions that may have a positive effect on modal shift, either by inducing more passengers to change the way in which they travel or by moving more goods by modes other than road transport, are as follows:

1. **Set objectives that are clearly expressed and measurable over time.** The modal shift targets set out in the 2011 White Paper on transport are quite general and, as demonstrated within the study, can be interpreted in different ways and thus lead to different interpretation of whether or not a target has been achieved. For example, different modal shares will be obtained by calculating modal split in terms of passengers or tonnes moved compared to if passenger-km or tonne-km were used. Similarly, different modal shares would be estimated if the focus was on different journey types, e.g. longer-distances compared to intra-city travel.

2. **Establish targets differentiated by transport segment.** Looking at the evolution of demand, it is clear that some demand segments can change quickly and thus deliver the desired results sooner. The case of intermodal transport is a good example, as its increase has driven the growth of inland waterway and rail freight demand over the last decade. In a context in which logistics is changing and other EU and national policies (e.g. on power generation) influence demand patterns, it is important to differentiate targets by segment. To this end, the data collected should be made available at a more disaggregated level so that progress can be better monitored.

3. **Adopt clear and definite measures to level the playing field.** In order to avoid distortions in the market and to prevent the introduction of regulations that may be based on incorrect background assumptions, it is paramount that the findings of the wide range of literature and studies that have been undertaken with specific reference to the EU market are taken into account in a coherent manner. For example, stakeholders and experts often claim that the differential treatment of the different modes, and the different charges and taxes that they face, are not fairly defined and applied according to the "polluter pays" principle. While the EU-wide harmonisation can be more easily done with respect to access charges, for taxes in general, it is more complex (but, for example, the exemption from fuel tax for aviation services should be tackled at the EU level).

4. **Redefine the priorities of the interventions on the network.** Over the last 10 years, the majority of EU funding of infrastructure has been invested in rail infrastructure (specifically on cross-border routes and in the context of Cohesion Policy). While the completion of the core network corridors is still considered to be a strategically important goal that needs to be pursued, the way it is achieved can be revised by prioritising the interventions that are more cost effective. This could lead to a focus away from projects targeting the high speed rail network (focusing only on those with a potential for strong demand) and instead putting more resources into ensuring interoperability between national networks.

5. **Strengthening support to investment in multimodal terminals.** Multimodal connectivity is not even across the EU; while it is acknowledged that the core network corridors and the rail freight corridors will represent the main axes for the development of intermodality across the EU, it is important that the whole EU territory is given the same opportunity to be connected by rail, following the principle of cohesion and accessibility policy. The distance that needs to be covered, and the associated costs, of the road haulage that occurs before and after transport on another mode are amongst the main barriers to multimodal transport: the improvement of accessibility should help to deliver the potential of this type of transport. This, however, does not mean that the planning of terminals and investment must follow an approach that aims to deliver the same level of multimodal connectivity everywhere: investment should be based on clear indicators of the demand levels and of the socio-economic conditions of the likely catchment area of the terminal.
6. **Support a consistent development of information sharing in freight transport.** Electronic information in transport is key for different reasons: informing about the services available, about the terminals and logistics platforms in terms of their accessibility, availability, transhipment facilities, services offered, performance etc. The Commission has already funded a web-based portal prototype containing this information; this could be further developed and maintained in order to provide comprehensive and updated information.
7. **Support the information exchange and the integration between the modes for passenger transport.** Multimodality is also essential for shifting passenger transport from private vehicle use to the use of more sustainable modes of transport. In this respect, increased interest in the concept of MaaS is pushing the development of platforms that can deliver a good integration of systems for information, ticketing and payment.
8. **Promote further the adoption of SUMPs and related actions in urban nodes.** This should be accompanied by the monitoring of the effectiveness of the measures implemented, through the adoption of common indicators measuring the performance of the plans. This is an area where the Commission is already investing a lot of time and resources, given the growing importance of urban areas as centres of population and of economic activities. While the responsibility for planning and funding cannot be made to be dependent on EU intervention, it is important that the cities adopting such plans have common approaches and indicators to measure their progress towards common policy objectives.
9. **Support the development of new technologies for both freight and passenger transport**. Multimodality and the future generations of mobility systems for passengers and freight require promotion and funding of, among others:
    - the research and innovation in areas that would help to achieve multimodality, but which are not specially related to a particular mode of transport, such as digitalisation, automation, artificial intelligence, energy management, etc.;
    - the development and implementation of any new technology within a specific mode of transport, while ensuring that this does not adversely affect integration, connectivity and interoperability.

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- European Spatial Planning Observation Network (ESPON) https://www.espon.eu/toolsmaps/espon-2013-database
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- Organisation for Economic Co-operation and Development (OCED) and International Transport Forum (ITF) http://stats.oecd.org/
- Statistical Office of the European Union http://ec.europa.eu/eurostat/data/database
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ANNEX A: LIST OF CONSULTED STAKEHOLDERS

NAME	ACRONYM	RANGE OF ACTIVITY
Community of European Railway and Infrastructure Companies	CeR	**Europe**
European association for forwarding, transport, logistic and Customs services	CLECAT	**Europe**
European Barge Union	EBU	**Europe**
European Environment Agency	EEA	**Europe**
European Logistics Association, Associazione Italiana di Logistica e di Supply Chain Management	ELA - AILOG	**Europe**
European Union Agency for Railways	ERA	**Europe**
International Air Rail Organisation	IARO	**International**
World Road Transport Organisation	IRU	**International**
Intergovernmental Organisation for International Carriage by Rail	OTIF	**International**
Polis Network	POLIS	**Europe**
Shift2Rail Joint Undertaking	S2R	**Europe**
Association of the European Rail Industry	UNIFE	**Europe**
International Union for road-rail combined transport	UIRR	**International**
European Road Haumeurs Association	UETR	**Europe**
Austrian FederaLEconomic Chamber (through the European Association of Craft, Small and Medium-Sized Enterprises – UEAPME)	-	**Austria**
Raab-Oedenburg Ebenfurter Railway Corp. (through the European Association of Craft, Small and Medium-Sized Enterprises – UEAPME)	-	**Austria**
Steiermarkbahn und Logistik GmbH (through the European Association of Craft, Small and Medium-Sized Enterprises – UEAPME)	-	**Austria**

ANNEX B: LIST OF CONSULTED EXPERTS

NAME	ROLE	INSTITUTION
Back Stefan	Director EU and sustainable transport	Transportföretagen/The Swedish Confederation of Transport Enterprises
Behrens Christiaan	Researcher	SEO Economic Research
Borkowski Przemyslaw	Associated professor at the Chair of Transport Economics, Faculty of Economics	University of Gdansk
Crozet Yves	Economist, full and Emeritus Professor	University Lumière Lyon 2
Garratt Mike	Transport economist, specialised in rail freight and maritime projects	MDS Transmodal
Mair Raimund De Wilt Wilhelmus	Unit C.1 – Water Unit C.3 –Air Unit	EC, Directorate-General for Environment
Quispel Martin	Consultant on transport policy, specialised in inland waterways	STC-Nestra
Rothengatter Werner	Emeritus Professor of transport economics and transport policy	M-Five GmbH Mobility, Futures, Innovation, Economics
Scheffer Michiel	Member of the Committee of the Regions; rapporteur the Committee’s opinion "Delivering on low-emission mobility"	Committee of the Regions
Turro Mateu	Professor of transport policy	Polytechnic University of Catalunya
Vickerman Roger	Emeritus Professor of European Economics	University of Kent

ANNEX C: QUESTIONNAIRE SUBMITTED TO STAKEHOLDERS

Question # 1 – PROGRESS

- In your opinion, do you believe that the goals of the 2011 White Paper on transport regarding transport modal shift are desirable? If you believe that they are not desirable, what should they be? Do you think that they are achievable?

Question # 2 – PROGRESS

- In your opinion, are some specific transport demand segments (e.g. urban, regional, cross border, long distance and international) performing better, in that we are seeing as a modal shift from aircraft, cars and trucks to other modes?

Question # 3 – POTENTIAL

- In your opinion, do you think that transport modal shift could have an impact on EU transport's competitiveness? If so, please explain what type of modal shift could have such an impact and could you explain the reason(s) why?

Question # 4 – POTENTIAL

- In your opinion, could new or unconventional transport systems and vehicles, or unconventional systems for goods distribution, have an impact on transport modal shift? Can you give a qualitative assessment of the extent to which this technological development might impact on modal shift (e.g. limited, moderate or significant)?

Question # 5 – POTENTIAL

- In your opinion, could any of the following developments have an impact on transport modal shift:

(i) seamless transport;
(ii) transport management and information systems facilitating smart mobility services;
(iii) traffic management systems for improved use of infrastructure and vehicles (e.g. SESAR, ERTMS, SafeSeaNet, RIS and ITS);
(iv) real-time information systems to track and trace freight and to manage freight flows (i.e. e-Freight);
(v) real-time passengers travel information; and
(vi) integrated booking and payment systems (e.g. integrated ticketing)?

- Can you give a qualitative assessment of the extent of the potential impact of these technological developments on modal shift (e.g. limited, moderate or significant)?

Question # 6 – BARRIERS

- In your opinion, what are the existing barriers still hampering transport modal shift towards more sustainable modes (e.g. legislative, administrative, infrastructural, operational, technical, taxable and others)? Which of these are still having negative consequences on transport modal shift and to what extent (e.g. limited, moderate or significant)?

Question # 7 – BARRIERS

- In your opinion, could the current market situation of road freight transport, as well as the degree of convergence of various rules and regulations, have an impact on transport modal shift? The rules and regulation that we have in mind include, amongst others:

(i) road user charges;
(ii) social and safety legislation;
(iii) transposition and enforcement of legislation in the Member States;
(iv) review of rules on the tachograph, with a view to further opening road transport markets; and
(v) the elimination of remaining restrictions on cabotage.

- Which modes are likely to benefit from such modal shift?

Question # 8 – BARRIERS

- In your opinion, do security concerns hamper transport modal shift (e.g. passengers and cargo screening procedures, security provisions in vulnerable areas such as major transport interchanges, terrorism, criminal attacks and piracy)? If so, how could this be addressed?

Question # 9 – BARRIERS

- In your opinion, are there any future challenges for the development of multimodality that need specific attention by the policy makers?

Question # 10 – MEASURES

- In your opinion, which measures would you suggest to stimulate the process towards transport modal shift to be in line with the goals of the 2011 White Paper on transport?

Question # 11 – MEASURES

- In your opinion, is there currently a level playing field between different modes? If not, what measures need to be taken to address this?

Question # 12 – MEASURES

- Can you give a qualitative assessment of the extent to which (i) initiatives for urban road pricing and (ii) access restriction schemes might impact on transport modal shift (e.g. limited, moderate or significant)?

Question # 13 – MEASURES

- In your opinion, to what extent does the promotion of sustainable behaviours and awareness of the availability of alternatives to individual transport (i.e. drive less, walk and cycle more, use of car sharing, park and ride, intelligent and integrated ticketing, etc.) impact on transport modal shift? Can you give a qualitative assessment of the extent of the potential impact of such policies (e.g. limited, moderate or significant)?

Question # 14 – MEASURES

- In your opinion, in order to deliver transport modal shift from aviation, road freight and car use, is further action needed at (i) national or (ii) regional/local level? If so, what?

Question # 15 – MEASURES

- In your opinion, should operators of more sustainable transport modes (e.g. infrastructure managers) be more actively involved in fostering transport modal shift?

Question # 16 – MEASURES

- In your opinion, does the deployment of policies to improve transport safety for more sustainable transport modes positively impact on transport modal shift?

Question # 17 – EVIDENCE

- In your opinion, what are the best practices and lessons to be learned based on the actions implemented in Member States? Are there any specific case studies you would like to mention to give us a sound supporting evidence in this respect (either in Member States or outside the EU)?

Question # 18 – EVIDENCE

- In your opinion, do multimodal infrastructure projects need to be financed more or less compared to the past years? Do you think that the current size of the EU financing envelope engaged is appropriate to support multimodal infrastructures projects? Is the budgetary allocation of the EU programme appropriately balanced between transport modes?

Question # 19 – EVIDENCE

- In your opinion, is the policy of the internalisation of external costs of transport appropriate for all transport modes, if we want to stimulate transport modal shift to more sustainable modes and avoid price distortions? Is the application of common principles adequate, while taking into account the specificity of each mode, or do you think that additional measures would be necessary?

Question # 20 – CONCLUDING REMARKS

- In your opinion, are there other relevant topics and aspects concerning transport modal shift that were not addressed throughout the previous questions?

Question # 21 – CONCLUDING REMARKS

- In your opinion, are there other case studies that we should look at? If you want suggest us literature that we should cover in our study, please list the useful references on the next page.

ANNEX D: QUESTIONNAIRE SUBMITTED TO EXPERTS

Question # 0 – YOUR EXPERTISE

- To provide context for your answers, could you provide an overview of your relevant expertise, e.g. by mode(s), policy area of academic interests?

Question # 1 – PROGRESS

- Do you believe that modal shift is a desirable objective of EU transport policy? Please explain your response. Are there alternative objectives that you would prefer to see to optimise the EU transport system, while still decarbonising transport?

Question # 2 – PROGRESS

- In your opinion, has progress been made in delivering the objectives of the White Paper in relation to modal shift? Has more progress been made towards meeting some objectives than others?

Question # 3 – PROGRESS

- In your opinion, do you believe that the EU's modal shift objectives are achievable (either in part or in full)?

Question # 4 – PROGRESS

- In your opinion, are some specific transport segments (e.g. urban, regional, cross border, long distance or international transport) performing better than others in terms of delivering modal shift in line with the objectives of the White Paper?

Question # 5 – POTENTIAL

- In your opinion, is there further potential for modal shift beyond the objectives set in the White Paper? Please explain your response.

Question # 6 – POTENTIAL

- Are there any technological developments (e.g. intelligent transport systems, internet of things, electromobility, drones, automated driving, etc) or other trends (e.g. shared mobility) that will support, or act against, achieving the modal shift objectives set in the White Paper? Please explain your response.

Question # 7 – POTENTIAL

- Are there any recent or ongoing policy developments (e.g. road user charges, social and safety legislation, market opening, improvements to vehicle fuel efficiency or cabotage) that will support, or act against, achieving the objectives set in the White Paper? Please explain your response.

Question # 8 - BARRIERS

- In your opinion, what are the existing barriers (e.g. legislative, administrative, infrastructural, operational, technical, financial or fiscal) that still hamper the delivery of the stated objectives of the Transport White Paper transport? Which of these are most relevant in your view and what is the extent of their effect?

Question # 9 - MEASURES

- In your opinion, which measures need to be put in place to overcome the barriers that you identified in the previous question?

Question # 10 – MEASURES

- In your opinion, are there any future challenges for the development of multimodality that need specific attention from policy makers?

Question # 11 – EVIDENCE

- In your opinion, what are the best practices and lessons to be learned based on the actions implemented in Member States?

Question # 12– EVIDENCE

- Are there any specific case studies that you would like to mention that would give us supporting evidence of how to deliver modal shift (either in Member States or outside the EU)? Is there any literature that is particularly important for our study?

Question # 13 – CONCLUDING REMARKS

- Do you have any other comments?

ANNEX E: ADDITIONAL MAPS AND TABLES

Map 10: Development of the high speed railway network in Member States

Source: UIC (2018)

Table 21: Development of the high speed railway network in Member States

Country	In operation to date		Under construction		Planned		Long-term planning		Total	
	Length [km]	Share %	Length [km]	Share %	Length [km]	Share %	Length [km]	Share %	Length [km]	Share %
Austria	268	2.9	281	16.3	71	3.7	-	-	**620**	**3.4**
Belgium	209	2.3	-	-	-	-	-	-	**209**	**1.1**
Czech Republic	-	-	-	-	-	-	810	14.6	**810**	**4.4**
Denmark	-	-	56	3.3	-	-	-		**56**	**0.3**
Estonia, Latvia and Lithuania (Rail Baltica)	-	-	-	-	-	-	740	13.3	**740**	**4.0**
France	2 814	30.7	-	-	-	-	1.713	30.8	**4 527**	**24.6**
Germany	1 658	18.1	185	10.8	-	-	210	3.8	**2 053**	**11.2**
Italy	896	9.8	53	3.1	-	-	152	2.7	**1 101**	**6.0**
Netherlands	120	1.3	-	-	-	-	-	-	**120**	**0.7**
Poland	224	2.4	-	-	484	25.0	598	10.8	**1 306**	**7.1**
Portugal	-	-	-	-	-	-	596	10.7	**596**	**3.2**
Spain	2 852	31.2	904	52.6	1.061	54.8	-		**4 817**	**26.2**
Sweden	-	-	11	0.6	-	-	739	13.3	**750**	**4.1**
United Kingdom	113	1.2	230	13.4	320	16.5	-	-	**663**	**3.6**
Total	**9 154**	**100.0**	**1 720**	**100.0**	**1 936**	**100.0**	**5 558**	**100.0**	**18 368**	**100.0**

Source: Elaboration of the authors based on UIC (2018)

Table 22: Volume of high speed rail passengers by country [billion p-km][138]

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Belgium	0.9	0.9	0.9	0.9	1.0	0.9	0.9	1.0	1.1	1.0	1.1	0.9	0.9	0.9	0.9	0.9
Czech Republic	-	-	-	-	0.0	0.0	0.1	0.3	0.3	0.2	0.3	0.3	0.3	0.2	0.2	0.2
Finland	0.1	0.1	0.1	0.2	0.2	0.3	0.4	0.6	0.6	0.6	0.7	0.7	0.7	0.8	0.7	0.6
France	34.5	37.2	39.5	39.3	41.2	43.0	44.7	47.8	52.4	51.6	51.7	51.9	50.9	51.2	51.0	50.0
Germany	13.9	15.5	15.3	17.5	19.7	21.4	22.0	21.9	23.8	22.5	24.2	23.4	24.9	25.4	24.7	25.3
Italy	5.1	6.8	7.1	7.4	7.9	8.5	8.8	8.8	8.9	10.7	11.6	12.3	13.4	12.8	12.8	12.8
Netherlands	0.1	0.2	0.2	0.7	0.7	0.7	0.7	0.8	0.9	0.9	0.3	0.3	0.3	0.4	0.2	1.0
Poland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.5
Portugal	-	-	-	-	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.6
Spain	1.9	2.1	2.2	2.0	2.1	2.3	2.6	2.5	5.4	11.5	11.7	11.3	11.2	12.7	12.8	14.1
Sweden	2.0	2.2	2.4	2.4	2.4	2.3	2.5	2.8	3.0	3.1	2.9	2.8	2.9	3.1	3.2	3.4
UK	-	-	-	-	0.4	0.5	0.9	1.4	1.0	1.0	1.0		4.4	4.4	4.4	4.4
Total	**58.6**	**64.9**	**67.7**	**70.3**	**76.0**	**80.3**	**84.3**	**88.5**	**97.8**	**103.8**	**105.9**	**104.4**	**110.4**	**112.3**	**111.4**	**113.7**

Source: Eurostat database

[138] Figure include all traffic with high speed rolling stock (including tilting trains able to run 200 km/h). This does not necessarily require high speed infrastructure.

Table 23: Share of high speed railway passengers with respect to total rail traffic by country [%]

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Belgium	11.2	11.1	11.0	10.6	10.8	10.7	10.4	10.2	10.4	10.2	10.0	8.5	*8.3*	*8.3*	*8.3*	*8.8*
Czech Republic	-	-	-	-	0.0	0.1	2.1	4.8	3.7	3.6	4.1	4.2	3.7	3.3	*3.2*	*3.0*
Finland	2.1	1.8	4.1	6.0	4.8	8.9	12.4	15.4	15.4	15.6	16.4	18.3	17.5	18.7	16.8	13.9
France	49.7	52.3	54.2	55.2	55.8	56.6	56.4	58.8	60.7	60.3	60.4	58.5	57.4	58.1	58.4	56.1
Germany	18.5	20.5	21.5	24.5	27.0	27.8	27.8	27.7	28.8	27.4	28.8	27.4	28.0	28.3	27.2	27.7
Italy	10.3	13.5	14.4	15.3	16.1	16.9	17.5	17.7	17.9	22.3	24.5	26.2	28.7	*26.3*	*25.6*	*24.5*
Netherlands	0.8	1.3	1.4	4.8	4.5	4.5	4.6	4.9	5.3	5.6	1.7	1.7	1.8	1.9	1.2	5.7
Poland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.7
Portugal	-	-	-	-	11.8	12.9	13.1	12.7	12.5	12.7	12.6	11.2	12.1	12.7	14.0	14.4
Spain	9.6	10.0	10.3	9.6	10.2	10.7	12.2	11.9	22.9	49.7	52.3	49.3	49.7	53.6	50.9	53.8
Sweden	24.8	25.5	26.9	27.2	28.0	26.1	25.9	27.0	27.0	27.0	*26.3*	24.8	25.0	25.8	26.6	26.4
UK	-	-	-	-	1.0	*1.0*	1.9	2.8	1.9	1.9	1.8		*7.2*	*7.0*	*6.7*	*6.6*
Total	**18.1**	**19.9**	**21.1**	**22.1**	**23.4**	**24.1**	**24.4**	**25.1**	**26.6**	**28.6**	**28.9**	**27.8**	**28.9**	**29.0**	**28.4**	**28.4**

Source: Eurostat database

Table 24: ERDF funds allocated to multimodal projects and share with respect to the total for all transport projects by country (2000-2006)

Country	Initial allocation		Final allocation		Actual expenditures	
	Budget [€ million]	Share %	Budget [€ million]	Share %	Budget [€ million]	Share %
AT	3.2	40	0.1	2	0.1	2
BE	1.1	4	0.9	2	0.7	2
CY	0.0	0	0.0	0	0.0	0
CZ	8.1	3	2.7	1	0.0	0
DE	0.0	0	0.0	0	0.0	0
DK	0.0	0	0.0	0	0.0	0
EE	0.0	0	0.0	0	0.0	0
ES	94.2	1	103.1	1	99.4	1
FI	9.3	25	6.8	22	5.7	21
FR	111.0	13	118.6	11	87.8	10
GR	0.0	0	0.0	0	0.0	0
HU	11.3	4	11.0	4	2.0	1
IE	0.0	0	0.0	0	0.0	0
IT	196.1	6	266.7	7	232.1	7
LT	0.0	0	0.0	0	0.0	0
LU	0.0	0	0.0	0	0.0	0
LV	0.0	0	0.0	0	0.0	0
MT	0.0	0	0.0	0	0.0	0
NL	3.5	11	6.4	14	4.4	13
PL	43.4	2	43.4	2	12.0	1
PT	552.8	17	484.4	15	434.1	15
SE	0.0	0	0.0	0	0.0	0
SI	0.0	0	0.0	0	0.0	0
SK	0.0	0	0.0	0	0.0	0
UK	63.5	12	69.5	12	57.5	12
Total	**1 097.6**		**1 113.6**		**935.7**	

Source: Elaboration of the authors based on Steer Davies Gleave (2010)

Table 25: EIB financed multimodal projects

Year	Country	Project	Loan [€ million]	Description
2002	Spain	Centro Intermodal de Barcelona II	25.0	Extension of intermodal freight handling terminal in the Barcelona port area
2003	Austria	Logistic Centre Linz	63.0	Construction of road-rail logistics centre for itemised freight in Linz
2003	Austria	Grazer Fracht Terminal (PPP)	20.0	Construction of road-rail intermodal freight centre in Graz
2003	Austria	Grazer Fracht Terminal (PPP)	20.0	Construction of road-rail intermodal freight centre in Graz
2003	Belgium	Port de Bruxelles – AFI	22.5	Construction of canal-side warehousing facilities and rehabilitation/expansion of a multimodal centre
2005	Italy	Interporto Catania	8.0	Construction and development of intermodal and logistics centre in Catania
2005	Italy	Interporto Catania	8.0	Construction and development of intermodal and logistics centre in Catania
2005	Spain	Centro Intermodal de Barcelona II	25.0	Extension of an intermodal freight handling terminal in the Barcelona port area
2006	Italy	Interporto Novara	23.0	Expansion of intermodal freight transport facility (road to rail) in Novara
2006	Netherlands	Rotterdam Delta Terminal	100.0	Construction of a barge feeder terminal and expansion of a container terminal
2008	Italy	SEA Aeroporti di Milano II	30.0	Extension of terminal and construction of new logistics centre at Malpensa Airport
2008	Italy	SEA Aeroporti di Milano II	30.0	Extension of terminal and construction of new logistics centre at Malpensa Airport
2008	Spain	Centro Intermodal de Barcelona II	50.0	Extension of intermodal freight handling terminal at Port of Barcelona
2009	Italy	SEA Aeroporti di Milano II	30.0	Extension of terminal and construction of new logistics centre at Malpensa airport
2009	Luxembourg	AAE European Rail freight	33.0	Purchase of 2 700 intermodal and standard freight wagons
2009	Spain	Puerto de Barcelona III	100.0	Expansion of container/multipurpose/short-sea shipping facilities and improvement of road and rail connections of port of Barcelona
2009	Spain	Puerto de Barcelona III	50.0	Expansion of container/multipurpose/short-sea shipping facilities and improvement of road and rail connections of port of Barcelona
2009	Estonia	Muuga harbour intermodal facilities	11.5	Expansion of Muuga harbour
2012	UK	Manchester multimodal transport	185.0	Acquisition of 32 tramcars and public transport improvements in greater Manchester area

2014	France	Route du littoral sécurisation et multi modalité	250.0	-
2015	France	Route du littoral sécurisation et multi modalité	250.0	-
2015	Spain	Bilbao port new quay and expansion	85.0	Construction of a new quay, a new passenger terminal and an intermodal facility
2016	Italy	Porto della Spezia	30.0	Extension and redevelopment of three terminals and rail development within the port
2017	Germany	Hafeninfrastruktur Hamburg TEN	150.0	Investment programme in the port of Hamburg
2017	Poland	Polish railway network modernisation	650.0	Upgrading, modernisation and renewal of the Polish railway network, including access to the main Polish sea ports, and other TEN-T lines
2017	Austria	OEBB suedstrecke Semmering Basis Tunnel	1 800.0	Construction of the 27 km Semmering base tunnel, around 24 km of track doubling, and construction of a new multimodal freight terminal near Inzersdorf
2017	Spain	Cilsa warehousing expansion	75.0	Development and construction of several new warehousing and logistic facilities in the Port of Barcelona
2018	UK	West Yorkshire multimodal transport	97.3	-

Source: Elaboration of the authors based on the EIB database on financed projects, EIB (2006) and Beikos (2018)

Table 26: Scope of road infrastructure charging system in the Member States (2016)

Country	Motorway network [km]	Light vehicles				Heavy Duty Vehicles						Differentiation	
		Cars		Vans		HGV 3.5-12 tonnes		HGV > 12 tonnes		Buses and coaches			
		Base type	Average charge [€/km]	Base type	Average charge [€/km]	Base type	Average charge [€/km]	Base type	Average charge [€/km]	Base type	Average charge [€/km]	Euro class	Noise
AT	2 185	Vignette	0.017	Vignette	-	Distance	0.224	Distance	0.352	Distance	0.335	Yes	Yes
BE	1 763	Tunnel toll	-	None	-	Distance	0.068	Distance	0.115	None	-	Yes	No
BG	734	Vignette	0.010	Vignette	0.021	Vignette	0.012	Vignette	0.020	Vignette	0.041	Yes	No
HR	1 314	Distance	0.116	Distance	0.172	Distance	0.261	Distance	0.380	Distance	0.380		No
CY	-	None	-	None	-	None	-	None	-	None	-	-	-
CZ	1 430	Vignette	0.011	Vignette	0.013	Distance	0.181	Distance	0.261	Distance	0.060	Yes	No
DK	1 216	Tolls for bridges	-	None	-	None	-	Vignette	0.028	None	-	Yes	No
EE	140	None	-	None	-	Time		Time	0.035	None	-	Yes	No
FI	810	None	-	None	-	None	-	None	-	None	-	-	-
FR	9 132	Distance	0.077	Distance	0.119	Distance	0.227	Distance	0.227	Distance	0.227	Yes	No
DE	12 949	Tunnel tolls	-	None	-	Distance[139]	0.134	Distance	0.138	None	-	Yes	No
GR	1 558	Distance	0.062	Distance	0.062	Distance	0.157	Distance	0.219	Distance	0.219	No	No
HU	1 180	Vignette	0.028	Vignette	0.025	Distance	0.203	Distance	0.295	Vignette	0.027	No	No
IE	385	Distance	0.097	Distance	0.165	Distance	0.228	Distance	0.285	Distance	0.165	No	No
IT	5 886	Distance	0.068	Distance	0.069	Distance	0.094	Distance	0.139	Distance	0.094	No	No
LV	1 507	None	-	None	-	Vignette	0.015	Vignette	0.023	Vignette	0.025		No
LT	1.695	None	-	Vignette	0.055	Vignette	0.015	Vignette	0.021	Vignette	0.089	Yes	No
LU	152	None	-	None	-	None	-	Vignette	0.023	None	-	Yes	No

[139] For vehicles above 7.5 tonnes.

MT	-	None	-	None	-	None	-	None	-	None	-	-	-
NL	2 678	Tunnel tolls	-	None	-	None	-	Vignette	0.019	None	-	Yes	No
PL	1 552	Distance	-	Distance	-	Distance	0.055	Distance	0.075	Distance	0.055		No
PT	2 942	Distance	0.096	Distance	0.172	Distance	0.220	Distance	0.245	Distance	0.220	No	No
RO	683	Vignette	0.006	Vignette	0.031	Vignette	0.011	Vignette	0.033	Vignette	0.045	Yes	No
SK	1 943	Vignette	0.010	Vignette	0.013	Distance	0.112	Distance	0.262	Distance	0.084	Yes	No
SI	600	Vignette	0.022	Vignette	0.023	Distance	0.180	Distance	0.302	Distance	0.180	No	Day/Night
ES	3 446	Distance	0.073	Distance	0.107	Distance	0.172	Distance	0.218	Distance	0.172	No	No
SE	2 088	Tunnel tolls	-	None	-	None	-	Vignette	0.030	None	-	Yes	No
UK	3 760	Mix[140]	-	None	-	None	-	Vignette	0.013	None	-	Yes	No

Source: Authors' elaboration based on Gibson et. al (2017), Schroten et al. (2017) and Member States vignette websites

[140] For specific motorways, bridges and tunnels.

Table 27: Ratios of short-term and long-term vignette prices and 2012-2018 comparison

Country	Cars				Vans				Ratio				
	Shortest term [€]	Validity [days]	Longest term [€]	Validity [days]	Shortest term [€]	Validity [days]	Longest term [€]	Validity [days]	Cars (2018)	Vans (2018)	Average (2018)	2012	change(2012-2018)
AT	9.00	10	87.30	365	9.00	10	87.30	365	3.76	3.76	3.76	3.8	1.0%
BG	8.00	7	50.00	365	8.00	7	50.00	365	8.34	8.34	8.34	7.9	-5.6%
CZ	11.99	10	58.03	365	11.99	10	58.03	365	7.54	7.54	7.54	7.7	2.0%
HU	9.13	10	131.83	365	18.25	10	131.83	365	2.53	5.05	3.79	3.7	-2.4%
LT	-	-	-	-	6.00	1	304	365	-	7.20	7.20	-	-
RO	3.00	7	28.00	365	6.00	7	96.00	365	5.59	3.26	4.42	5.4	18.1%
SK	10.00	10	50.00	365	10.00	10	50.00	365	7.30	7.30	7.30	7.1	-2.8%
SI	15.00	7	110.00	365	15.00	7	110.00	365	7.11	7.11	7.11	8.2	13.3%

Source: Authors' elaboration based on Gibson et. al (2017) and Member States vignette websites

The study provides a comprehensive analysis of the progress and potential of modal shift from road to more sustainable transport modes, with respect to the policy objectives set in the 2011 White Paper on transport. The study focuses both on passenger and freight transport, highlighting main barriers and factors that are hampering a more effective modal shift at EU level, and providing policy recommendations for the way forward.

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